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NIAGARA AS A TIMEPIECE.

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NIAGARA FALLS IN HISTORY.—Guided by an Indian chief, La Salle and Hennepin visited Niagara Falls in 1678, but it was not until 1697 that Hennepin published his picture of the cataracts, which, in spite of the rude perspective of two centuries ago and the prominence of the *voyageurs*, is famous for having been the first pictorial representation of the falls of Niagara (Fig. 1).

The existence of the falls was known a century and a half earlier than Hennepin's narrative through reports of the Indians to Jacques Cartier (1535). In the early part of the seventeenth century, Champlain and several Jesuit fathers mention the cataract, which was mapped by two of them under the name of "Onigara." Reproductions of Hennepin's picture were frequently made, but there appear to be no fairly good drawings of the falls preserved older than that of Lieutenant William Pierie, of date of 1768 (Fig. 2).

The scenery and even the geology of the Niagara district have been known for nearly half a century, and hundreds and perhaps thousands of papers have been published upon the falls of Niagara. Yet "problems settled in a rough and ready way by rude men absorbed in action demand renewed attention and show themselves to be unread riddles . . . when men have time to think." Even now it is scarcely fifteen years since the history of the falls began to be known.

If we look at a picture of the Falls of Montmorency, near Quebec (Fig. 3), cascading about two hundred and seventy-five feet over the wall of the St. Lawrence almost directly into the river

itself, without flowing through any cañon whatever, and then glance at the gorge of Niagara River, seven miles long, of which only a fragment can be seen in a picture (Fig. 4), the striking difference awakens inquiry. The cause does not lie in either the magnitude of the streams or in the character of the rocks; it is a question of the difference of the age, for Niagara Falls once cascaded from the edge of the mountain wall (Fig. 16) directly into the expanded waters of the Ontario basin just as the Montmorency stream is pouring into the St. Lawrence River to-day.

EARLY ESTIMATES OF THE AGE OF NIAGARA FALLS.—All attempts at reducing geological time to solar years meet with great difficulties, yet Niagara Falls have been used as a chronometer as

FIG. 1.—FACSIMILE OF A VIEW OF NIAGARA FALLS BY FATHER HENNEPIN.

frequently as any other natural phenomenon, and indeed Niagara is perhaps the best measurer that we have. Even at an early date, when the antiquity of the earth was not a popular doctrine, Andrew Ellicott (in 1790) divided the length of the gorge by the supposed rate of recession of the falls, and assigned fifty-five thousand years as the age of the cataract. Forty years later Bakewell reduced the time to twelve thousand years, and a few years afterward Lyell's estimate of thirty-six thousand years became popular and remained so until about fifteen years ago. This method of dividing the length of the chasm by the rate of recession was correct as far as it went, but even the rate was not then known.

METHOD OF COMPUTING THE AGE OF THE FALLS.—Many years

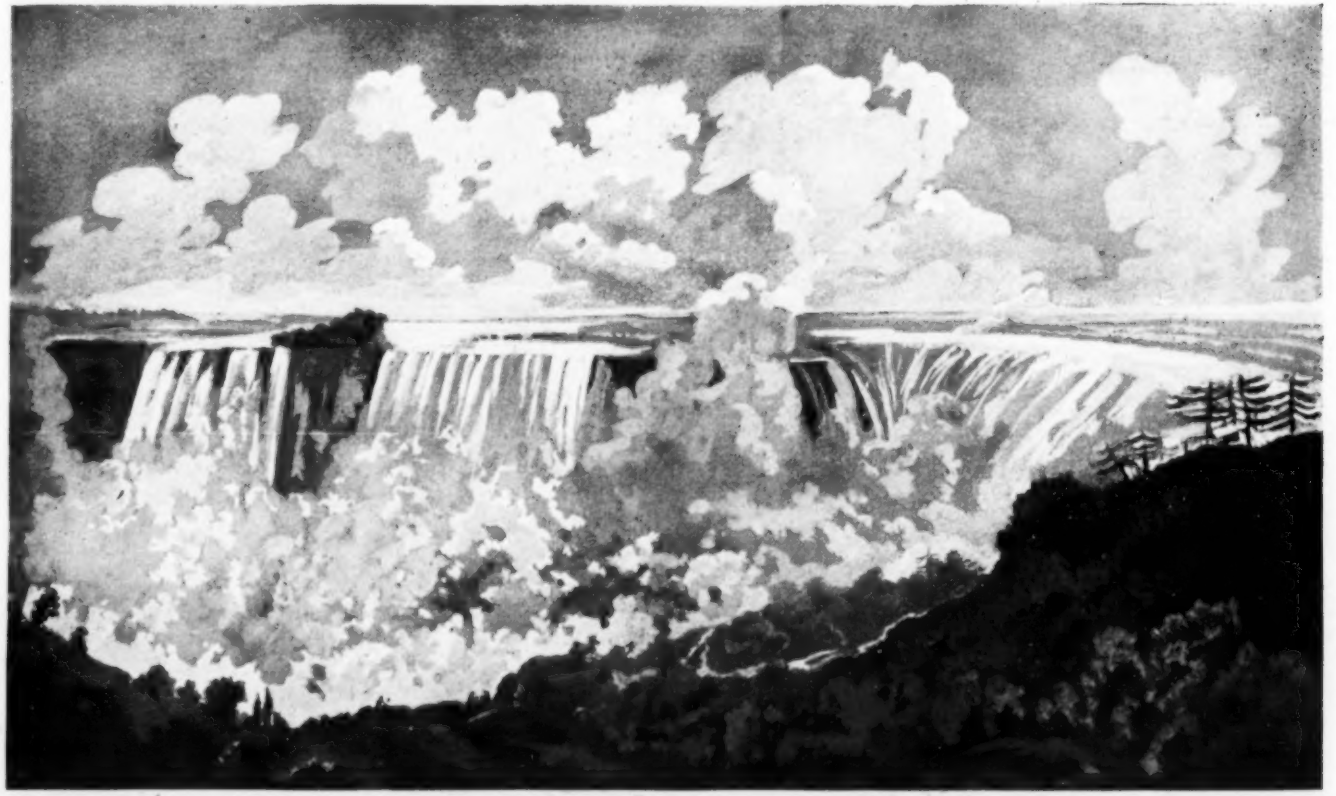

FIG. 2.—CATARACT OF NIAGARA FALLS, WITH THE ADJACENT COUNTRY. (From a drawing on the spot by Lieutenant William Pierie, of the British Artillery, 1768.) This picture was kindly furnished by Peter A. Porter, Esq., of Niagara Falls.

ago Prof. James Hall laid the foundation of all future calculations when he made the first instrumental survey of the crest of the falls. The changes in the crest have been measured three times since, and from these surveys the mean recession for nearly half a century is now known and has been found to be much more rapid than was formerly supposed. If the whole history of the falls of Niagara were thus told, then it would appear that their age is

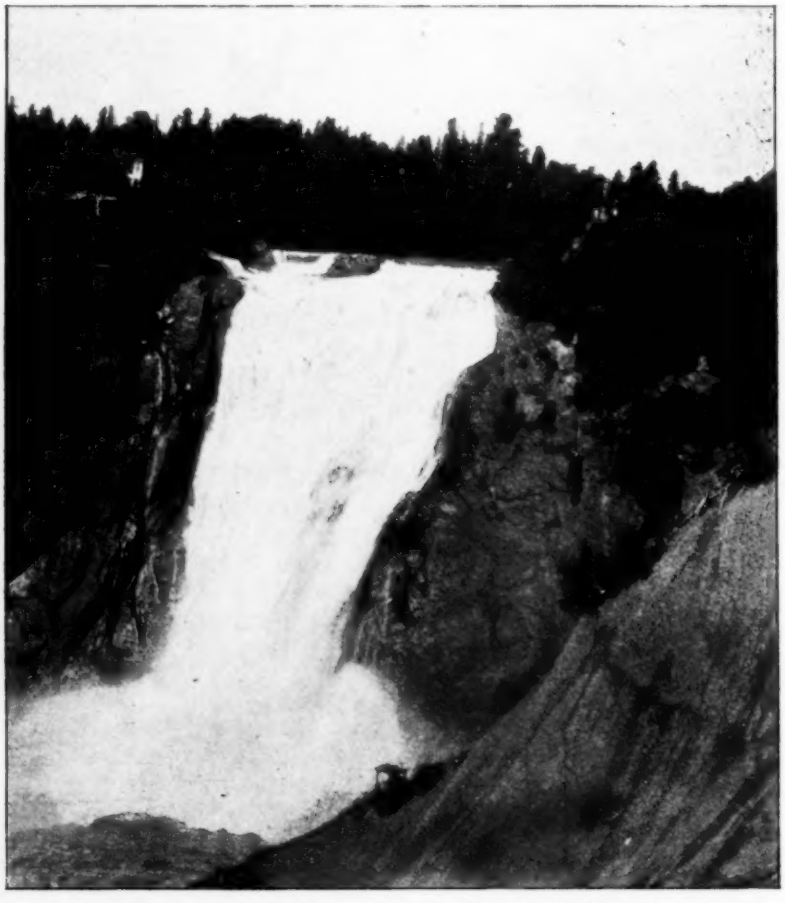

FIG. 3.—FALLS OF MONTMORENCY. (About 275 feet high.)

about nine thousand or ten thousand years. Indeed, some writers, among others Mr. Gilbert, took this reduced estimate and minimized it to seven thousand years, not knowing or overlooking the history of the river which tells of the changing conditions; but these views he now abandons. The chronometer needed correction. During a term of several years of actual work, but extended through a decade and a half, for the investigations were often blocked with difficulties, the writer has been able to decipher

many phases in the history of the lakes in their bearing upon the growth of the falls, and only after that field work could any attempts at computing the age of the falls be made. A few of the necessary discoveries may be referred to: (*a*) The Niagara River did not drain the Erie basin in ancient times, and consequently there was no ancient river channel ready for the modern stream. (*b*) All the features of the chasm are modern, and only very slightly modified by the older forms of land sculpturing. (*c*) After the birth of the river, Huron and the sister lakes did not empty into the Niagara drainage until comparatively recent times, and therefore, on account of draining only the Erie basin, the volume of the water cascading over the early falls was small. (*d*) Then the descent of the river varied greatly, being for very long ages less than now, and again temporarily much greater. (The observation of the greater height of the falls was made by Prof. G. K. Gilbert, who has followed the writer in the other important points named.) (*e*) The determination of the amount of work accomplished by the falls during each of the episodes of the river seemed the most difficult, but this has been accomplished with partial success. These things have been mentioned to show that the computation of the approximate age of the falls has been a complex question and also one of tedious delays, yet a problem that will continue to awaken interest so long as men endeavor to ascertain the antiquity of the ice age and the correlated antiquity of man. Niagara River is perhaps our best chronometer, and by applying the age of the falls to the deserted shore lines the antiquity of possibly man-inhabited river banks of distant regions and forgotten times will be discovered. Directly the determination of the age of the falls is a stepping stone to the date of the close of the ice age. Under these circumstances the investigations seem to justify the presentation of the results to the general reader, leaving to the essayist the repetitions of the other geographical or picturesque features or the pretty stories of Niagara. Even the great Lyell had no better means of ascertaining the antiquity of the falls than mere conjecture, for a long period of observation was necessary. Strangely, however, his suggestion was not far from the computations based upon our increased knowledge. This coincidence arose from the occurrence of compensating errors, those corrected on the side of reduction of time used alone giving results further from the truth than the mere conjecture, as the varying conditions of the river which increase its antiquity were not known.

Some Modern and Ancient Features of the Niagara District.—The map of the Niagara district (Fig. 5) shows a table-land a few feet above the surface of Lake Erie, and extending northward for nineteen miles to the edge of the Niagara

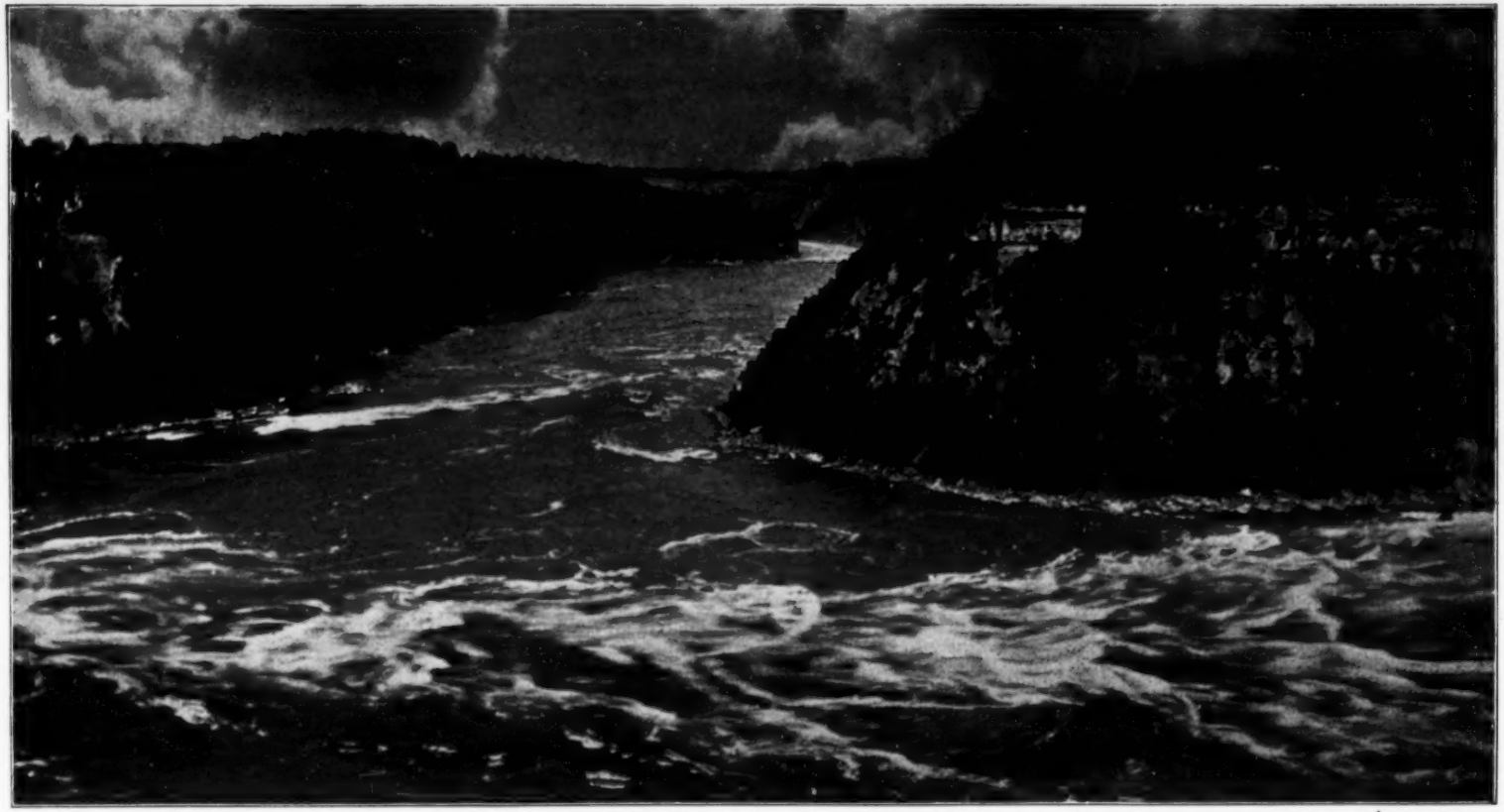

FIG. 4.—THE NIAGARA GORGE BELOW THE WHIRLPOOL.

escarpment, where there is a sudden descent of two hundred and forty feet to the lower plain, that gradually slopes for eight miles farther to the present shores of Lake Ontario, whose waters are three hundred and twenty-six feet below the surface of Lake Erie.

The features of the plain which have a bearing upon the development of the Niagara River are, a low ridge crossing the river just north of the outlet of Lake Erie; a comparatively level plain underlaid by soft rocks, extending thence to near the head of the rapids above the falls, north of which, to the brow of the escarpment, the country rests upon hard limestones, with underlying strata of soft shales and occasional layers of more persisting rocks. These softer shales form the foundation of the country between the end of the gorge at the brow of the mountain near Queens-

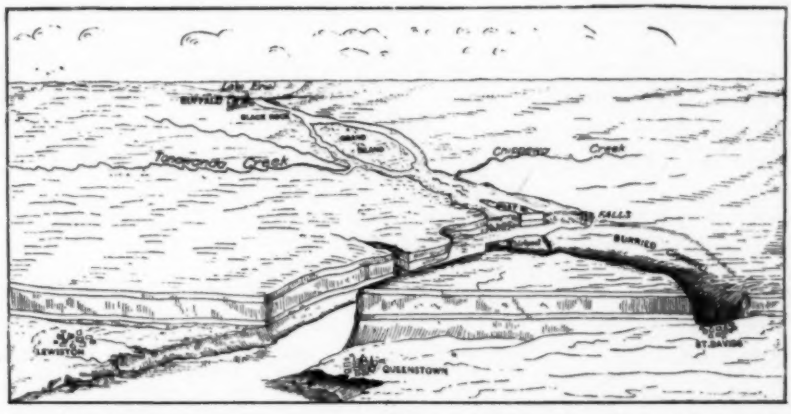

FIG. 5.—BIRD'S-EYE VIEW OF THE NIAGARA DISTRICT (Pohlman). The buried channel or valley from the falls to the edge of the mountain at St. Davids is about a mile and a half broad, but it is not anywhere nearly as deep as the Niagara gorge.

ton (and Lewiston) and Lake Ontario. The work of the river has been to remove the soft rocks and undermine the thick and hard capping limestones. The chasm of the Niagara River is simply chiseled out of an elevated table-land, whose surface is a remarkably level plain, covered with towns, villages, and farms, extending apparently without a break until one is surprised at coming suddenly upon the brink of an abyss, without meeting with the sloping features which constitute the usual approaches to deep valleys. The feature of the gorge with unbroken perpendicular walls is shown in Figs. 6 and 7, which are characteristic forms of modern cañons. If the valley were of great antiquity it should have been two miles or more in width, in place of a gorge of a quarter of a mile wide, and it should have had scarcely any fragments of perpendicular walls standing. Indeed, an old valley, buried beneath some ninety feet of drift, does cross the course

of the modern river in the region of the falls themselves, but this is a mile and a half wide. Its section is shown beneath the drift in Fig. 8.

Indeed, there was no ancient outlet of the Erie basin in the vicinity of Niagara River, but the ancient drainage course was

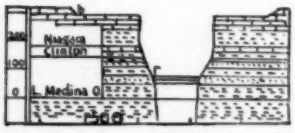

FIG. 6.—SECTION ACROSS THE NARROWS JUST NORTH OF THE RAILWAY BRIDGES (*dd*, Fig. 9). *b*, Original bank of the river; *r*, surface of the river; L O, level of lake; floor of cañon eighty feet below lake level.

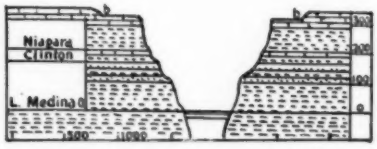

FIG. 7.—SECTION HALF A MILE FROM THE END OF THE CAÑON (*gg*, Fig. 9). *bb*, Terraces of river at the original level; L O, level of Lake Ontario; bottom of river about eighty feet below the surface of Lake Ontario.

discovered about fifteen years ago to have been some forty miles farther west, where is now the buried channel of the ancient Erigan River, terminating in the extreme western end of Lake Ontario. Thus the necessity of a preglacial Niagara River was removed.

To describe the features of the Niagara River more accurately, so as to interest special readers, it may be added that from Lake Erie to the rapids above the falls the river is from half a mile to more than a mile wide, and flowing at the surface of the country with banks only a few feet high. The gorge is thirty-six thousand five hundred feet long and varies from nine hundred feet to fourteen hundred feet wide at the top, and it is three hundred and forty feet deep near the outlet. The width of the river itself at the narrows is only three hundred feet and four hundred at outlet of whirlpool, although elsewhere much broader. The rubbish in the chasm forms loose heaps of broken rock, which is constantly falling from the sides, and building up sloping banks along the water's edge, where the rains and river are constantly washing them away, and thus the cañon is slowly being widened into a common form of an old valley. The river, both near the foot of the falls and seven miles below, at the outlet of the gorge, is nearly one hundred feet in depth, descends fifty feet by the rapids above the falls, which leaps one hundred and fifty-eight feet into the abyss, from which it further descends another hundred and ten feet by the rapids below the falls. These features are

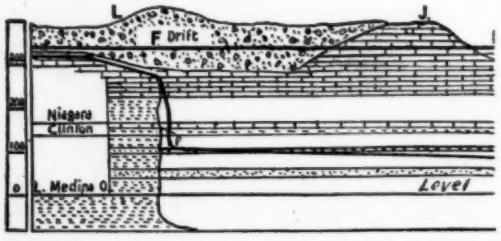

FIG. 8.—SECTION AT THE SITE OF THE FALLS, SHOWING THE TRANSVERSE BURIED TONAWANDA VALLEY, F, cut out of limestones for breadth of a mile and a half and depth of ninety feet; rectangular shading represents the Niagara limestones; L O, level of Lake Ontario; F, foot of falls.

shown on the map of the gorge (Fig. 9), and in the longitudinal section in Fig. 16.

THE WHIRLPOOL AND ITS RAVINE.—The elbow of the Niagara gorge at the whirlpool has given rise to much speculation and has led to great confusion. Fifty years ago Sir Charles Lyell supposed that it indicated an ancient course of the river itself, which extended thence to the St. Davids' Valley, about four or five miles distant, although the country forms a level floor which told of no buried channel (see Fig. 5). This mistake arose from the perpendicular walls of the whirlpool basin, without the necessity of sloping sides for ancient valleys being then perfectly known, and without the author evidently going through the ravine where rocks were exposed. The serious feature of the mistake was that it led to the supposition that perhaps much of the gorge above the whirlpool was older than that portion below, and, becoming filled with drift, the river had only the drift filling to remove in modern times. This idea caused Dr. Pohlman to reduce the age of the falls to three thousand years. But almost universally the error of a deep preglacial

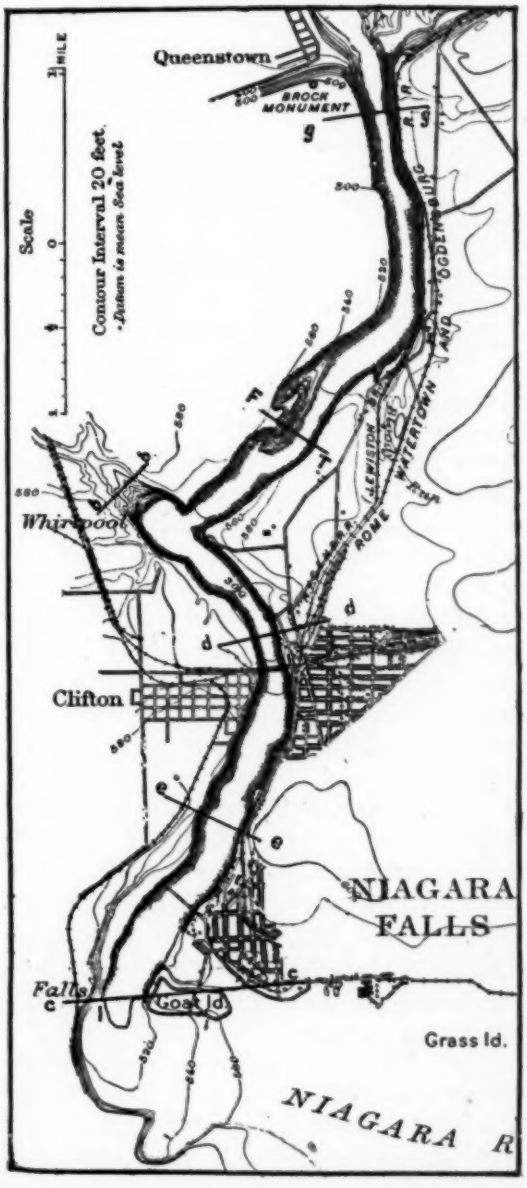

FIG. 9.—MAP OF THE NIAGARA GORGE (United States Lake Survey), SHOWING ITS VARIABLE WIDTH AND CROSS-SECTIONS.

gorge was followed, as most authors absorb the work of others without verifying it throughout. In this matter even the present writer, in the beginning of these investigations (1881), partially accepted Lyell's idea, but distinctly showed that the buried ravine from the whirlpool was not preglacial but probably that of a small interglacial stream, and not that of the Niagara River. Prof. Claypole found rocks in the ravine, and then the writer immediately corrected his statements (1887), and later explained the whole history; but apparently Prof. Gilbert had forgotten these observations and went back to Lyell's views in their entirety. The mistake was easily corrected by going through the ravine, where rocks three hundred feet above the bottom of the river are exposed, as shown in Figs. 10 and 11. The exposed rocks along the western side of the ravine show the slope as in section, which is a characteristic form of ancient valleys in contrast to the vertical walls of the cañon (Figs. 6 and 7), while on the eastern side the rocks are covered with drift and landslides, but at the same time demanding sloping walls beneath. Thus the presence of rocks so high in the ravine removes from the calculations of the work of the river the obstructions of early observers, and relegates the hamlet of St. Davids, made famous the world over, to its peaceful repose.

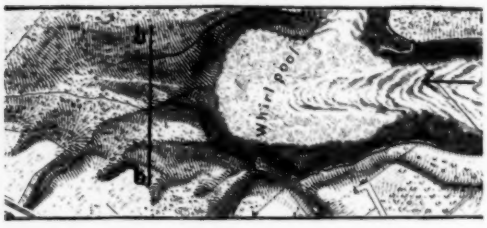

FIG. 10.—MAP OF THE WHIRLPOOL RAVINE. *bb*, Position of section (Fig. 11).

It is perhaps necessary to explain the form of the whirlpool basin. A moderately shallow valley, now buried, was formed in ancient times by a stream flowing from near the railway bridges, and extending down by way of the buried ravine (which has given so much trouble) to join the ancient Tonawanda River a little to the west (see Fig. 5). Most of the capping limestones in the ancient little ravine near the site of the whirlpool had been removed, leaving at or near the surface only soft, shaly rocks, yet three hundred feet above the bottom of the river. When the modern falls had receded so as to reach the edge of the little buried valley, it found the surface occupied by loose materials which for a short distance the river easily swept out, and thus by the cir-

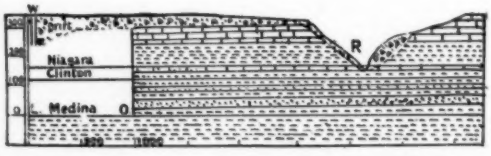

FIG. 11.—SECTION ACROSS THE WHIRLPOOL RAVINE: located at *bb* (Fig. 10).

culating currents was the form of the basin started, and afterward deepened in the soft shales. The rocks at the end of the basin are always obscured by the landslides of the overlying drift materials.

NIAGARA FALLS CROSSING THE ANCIENT AND BURIED TONAWANDA RIVER.—Reference has been made to the ancient buried valley westward of the Niagara. In olden days the rains, rills, and rivulets were everywhere acting upon the surface of the land and producing broad, flattened features which are characteristic of old topography. Through such a valley flowed the ancient Tonawanda River (partially recognized by Dr. J. Pohlman), draining the Niagara district (as indicated in Fig. 5). This valley in the vicinity of the falls was about a mile and a half wide and ninety feet lower than the rocky rim which bordered the northern side (see Fig. 8), which barrier is now exposed between the railway and the carriage bridges over the river. In wells this ancient valley has been found to extend in the direction of the St. Davids Valley (Fig. 5), which is comparable in size to it, in place of turning off at right angles, as does the modern river at the location of the falls. This ancient Tonawanda River never drained the Erie basin, and when it afterward became filled with drift it did not determine the character of the modern river, except to give rise to the magnificent rapids above the falls (as shown in Fig. 17).

EFFECTS OF THE DEPRESSIONS OF THE ANCIENT SURFACE AND THE GEOLOGICAL STRUCTURE UPON THE RECESSION OF THE FALLS.—The partial scooping out of the superficial limestones in the vicinity of the falls and at the whirlpool is the only important feature which has noticeably affected the excavation of the modern river channel, and this only to a very small extent, for the ancient depressions were filled with the rubbish of the drift period, which loose material was protected from being carried away by the flowing currents; and even after the last barrier of rock had been removed by the retreat of the falls, the river had nearly as much work as ever to do, for the recession of the falls is by the undermining of the capping limestones, and not on account of their being worn away by the river to an appreciable extent. Furthermore, the regularity of the recession has been largely maintained by the remarkably uniform character of the beds of rocks, which for a considerable portion of the length of the cañon are almost horizontal, and only at the lower end do they dip as much as fifteen or twenty feet in a mile. Now all these explanations mean that the character of the country and the geological formations would not cause any great variation in the rate of the recession of the falls, but those changes were due to the other and farther reaching causes.

MODERN RECESSION OF THE FALLS.—The modern rate of retreat of the cataract during forty-eight years has been determined by comparing the crest of the falls, carefully mapped by four surveys—the first by Prof. James Hall in 1842 and the last by Mr.

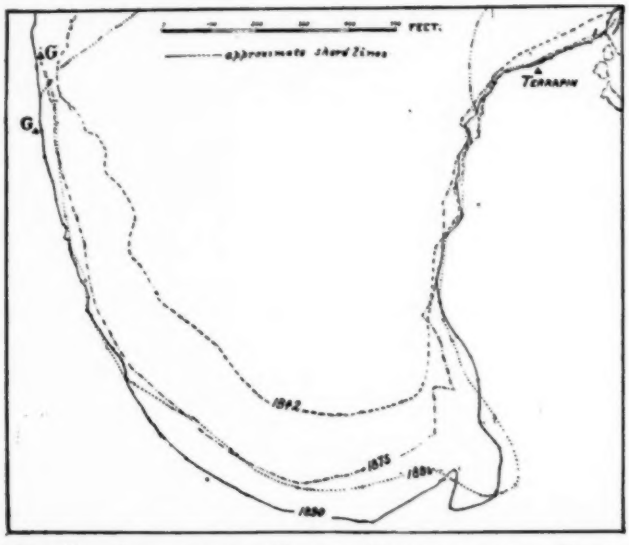

FIG. 12.—THE FOUR SURVEYS OF THE CANADIAN FALLS, SHOWING THE RETREAT OF THE CATARACT, IN WHICH SOME INACCURACIES ARE APPARENT. (Kibbe.)

Augustus S. Kibbe in 1890. Between the times of these surveys not merely the historic Table Rock, but six acres of rocks forming the floor of the river fell away by the undermining action of the falls, and the center of the cataract moved upward for a distance of two hundred and twenty feet. From the 275,400 square feet thus removed it is found that the mean annual recession has been four feet and a sixth a year for the Canadian falls and two thirds of a foot for the American cataract. The recession is shown in Fig. 12.

The work of the falls is not uniform, for there are years of rapid central recession and slow lateral expansion, followed by even a total central rest and rapid lateral enlargement of the curve. From an approximate estimate of the variation in the amount of work due to the physical and geological structure of the district, the mean rate of recession of the falls under existing volume of water and descent of the river may perhaps be reduced to 3·75 feet a year, which factor alone would indicate the age of the cataract to be ten thousand years. But this simple story would leave out of consideration the variability of the volume of Niagara River and the descent of the cascades.

THE STORY OF THE LAKES AND THE BIRTH OF NIAGARA FALLS.—At the close of the ice age, and after the geological

broom had swept the accumulated dirt of ages from the northern country and filled up the great valleys, the lake region was covered with water; whether arms of the sea, as is probable, or as lakes, of which the barriers are not indicated, is immaterial in the history of the river, for under either condition the old shores were produced, and these we have surveyed. From them we learn the story that all the lakes formed one broad sheet named the Warren water. From time to time its surface was lowered, and at each pause new stands were formed, only to be abandoned by further sinking of the water. At last the aboriginal Warren water subsided so that it became divided in two smaller sheets—the Algonquin gulf, occupying more or less of the basins of Lakes Huron, Michigan, and Superior, and the Lundy gulf, extending over much of the Erie and the Ontario basins. With the continued lowering of the gulf, or, more correctly, the rising of the land, for no evidence of lake barriers has been found, the Lundy gulf became dismembered, forming Lake Erie, then much smaller than now, and the Iroquois gulf occupying the Ontario basin, the deserted shores of which have now an elevation much above the

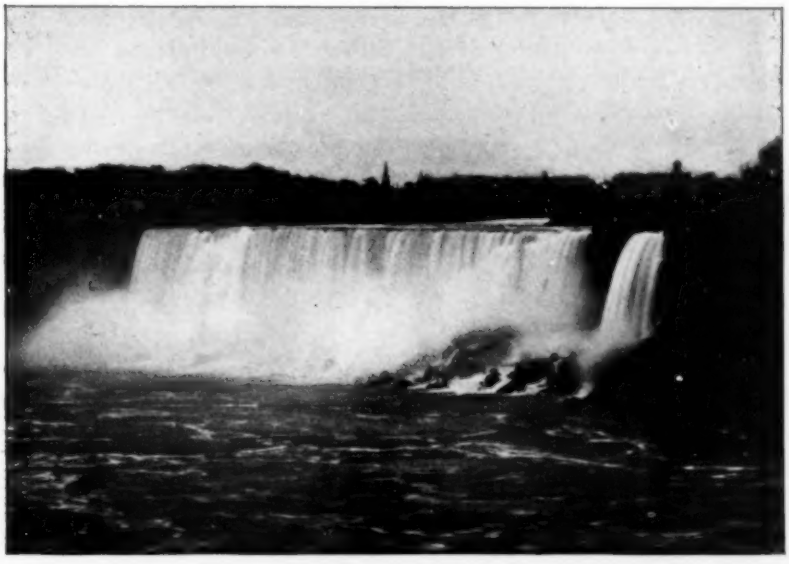

FIG. 13.—VIEW OF THE AMERICAN FALLS.

present altitude of the lake. Then Niagara Falls had their birth, and the river descended only a little more than half as great a height as to-day into the gulf (Fig. 16) which came to the mouth of the gorge. The lowering continued until the descent of the river was much greater than at present, and the shores of the lake receded not merely eight miles to the present margin of the

lake, but four miles farther. Again, the waters of Ontario were raised and the descent of the river was reduced to the present amount. Thus it is apparent that at the birth of Niagara Falls the cataract was much smaller than now, and very much resembled the size of the American Falls as shown in Fig. 13.

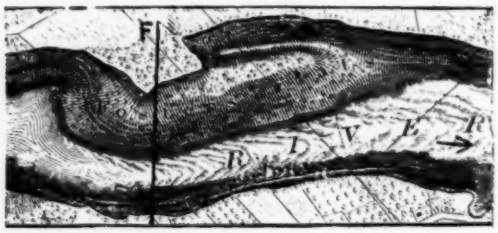

FIG. 14.—MAP OF THE GORGE AT FOSTER'S FLATS. F, Location of the cross-section (Fig. 15).

With the discovery of the history as here set forth, we had to wait several years before any clew was obtained as to how far the falls receded during each of the episodes. But at last the inquiry was partially successful; for at Foster's Flats (Fig. 14, see also Fig. 9), about two miles and a half above the mouth of the gorge, the remains of an old terrace occur (Fig. 15) at the height which shows that the falls had receded to that point before the descent of the river was greatly increased or the volume of the water enlarged to the drainage of all the upper lakes.

In this determination of the distance to which the falls had probably receded before Lake Huron drained into Lake Erie, Prof. Gilbert has followed the writer. Now, by applying the laws of the variability of erosion to the observed modern rate of recession of the falls, an approximate determination of their antiquity became possible.

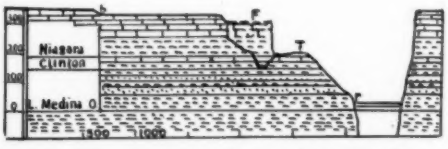

FIG. 15.—SECTION OF THE GORGE AT FOSTER'S FLATS (FT, Fig. 9). Platform (F) of the old river floor projecting into the cañon. Its section is shown in broken shading, but with ravines descending from both sides of it; T, rock terrace surmounted by huge blocks of Niagara limestones; *b*, original river terrace; *r*, surface of river; L O, surface of Lake Ontario. Bottom of river about eighty feet below the surface of the lake.

CAUSES OF FLUCTUATION IN THE VOLUME AND DESCENT OF NIAGARA RIVER.—In the survey of the deserted shores it was found that since they were formed as old water-lines they have been tilted upward toward the north and east at variable rates, from a few inches in a mile at the southwest to four or even seven feet per mile in the opposite direction. The phenomenon belongs to the consideration of the history of the lakes, but its effect was to tilt the lake basins so that the water ran over the southern rim of Lake Huron into the Niagara drainage. So, also, the tilting of the Ontario basin raised the barrier at the outlet and caused the waters to rise and flood the lower lands at the head of the lake, and shorten the Niagara River by four miles

or more, and reduce the descent of the river by eighty feet or more.

EPISODES OF THE NIAGARA RIVER AND THEIR DURATION.—At first the river flowed without falls, as shown by the old banks and terraces, for a period estimated at a thousand years. Then the waters of the lower lake began to subside, whereupon the Niagara Falls had their birth. The new cataract slowly grew in height, although characterized by temporary pauses, until the river cascaded two hundred feet from the tableland into the edge of the gulf or lake which occupied the Ontario basin, as shown in Fig. 16.

The volume of the water of Lake Erie is about one fourth that of all the upper lakes, and only this proportion of the discharge of the modern Niagara River formed the abrading agent of the falls at that early date. This general condition lasted for seventeen thousand two hundred years.* After this episode, the descent of the river was increased to four hundred and twenty feet, and the lake receded twelve miles from the foot of the mountain, and then there was a series of three cascades, the lower always gaining upon the upper on account of the softer rocks. Yet the increased amount of work to be done, even though easier than the recession

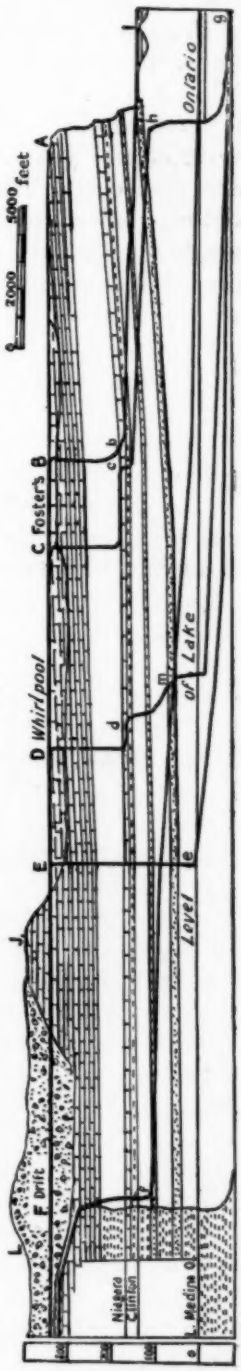

FIG. 16.—LONGITUDINAL SECTION, SHOWING THE RETREAT OF THE FALLS AND THE GEOLOGICAL STRUCTURE. A, Brow of escarpment and original site of falls; 1, Iroquois beach and level of that water; B *b* I, chasm at the end of the first episode; C *c h g*, falls retreating in three cascades, but from *h* to *g* the slope was extended over a distance of twelve miles beyond the escarpment; D *d m g*, position of cataracts at the end of the second episode; E *e g*, development of gorge at the end of the third episode; F, present site of falls, and F *m g*, the modern cañon; *g*, level of the lowest stage of water in the river history; L, Lundy beach capping the drift; J, Johnson's ridge. Broken shading about whirlpool shows occurrence of drift on west bank only with rock on the eastern; block shading represents limestone; dotted, sandstone; broken lines and unshaded portion, shales. Bottom of river eighty feet below present surface of Lake Ontario, as shown in figure.

* For the methods of computation of the duration of the episodes of Niagara Falls see Duration of Niagara Falls and the History of the Great Lakes, pp. 1–126, 1895. Also see Duration of Niagara Falls, American Journal of Science, December, 1894, pp. 455–472—both works being by the writer.

of the upper cascade, prolonged the episode to six thousand years, when Foster's Flats were passed. By this time the waters of Lake Huron were probably turned into the Niagara by way of Lake Erie. With the increased magnitude of the river the falls are thought to have receded as far as the head of the whirlpool, requiring four thousand years. By the close of this stage there were some important changes in the river, as when the narrows of the whirlpool rapids were excavated, and the three cataracts of the second episode appear to have been united into one great fall. With the increased volume of water at the maximum height of the falls, as at the apex of the modern horseshoe cataract, the recession was very rapid, so that the falls receded to above the railroad bridges in eight hundred years more. It was in the next episode that the descent of the river was reduced from four hundred and twenty feet to three hundred and twenty-six feet, which is that of the present day. These changes of height of falls and volume of the river must not be supposed to have been sudden, and, although they were secular, yet there were long periods of rest, as shown by the landmarks, which are mostly obliterated where they were imperfectly engraved during short epochs of repose. The first stage of the last episode is characterized by the retreat of the falls through the great rocky barrier (Johnson's Ridge, *e e*, Fig. 9) on the northern side of the buried Tonawanda Valley. Beyond this barrier the river speedily removed some ninety feet of drift for a distance of a mile and a half to the head of the rapids above the horseshoe cataract, and the recession across the buried valley has been the last stage of the present episode of the falls. Here the necessary time for the retreat of the falls since passing the railway bridges has been three thousand years.

Adding the duration of the various stages of the river together, the age of the falls is computed at thirty-one thousand years, or of the river thirty-two thousand years. These figures are based upon the severest analytical methods at present attainable, but the discoveries in the physics of the river cover most of the doubtful points; yet in the determination of the amount of work performed in the middle episodes some points are open to revision, but the errors they cover form only a small portion of the life of the cataract, and a little time, more or less, would not greatly change the results given. No general guesses or objections have been found worthy of consideration. The determinations had to be attempted in parts, and the aggregate results have been confirmed by two other sets of investigations: one on the relative amount of tilting of the deserted shores, and the other upon the rate of the rising of the land in the Niagara district, which has been found to be about one foot and a quarter a century, but much more rapidly to the north and east.

NIAGARA FALLS NARROWLY ESCAPED EXTINCTION.—Fifteen hundred years ago the terrestrial movements raised the Johnson barrier to the Erie basin so high that the waters of that lake reached not merely the level of Lake Michigan, but the point of turning all the water of the upper lakes into the Mississippi drainage by way of Chicago. But the falls were then cutting through the ridge, and when this was accomplished, before the change of drainage was completed, the surface of Lake Erie was suddenly lowered by many feet, and thus the falls were re-established for some time longer.

DEATH OF THE FALLS.—Slowly, year by year, one sees the cataract wearing back and suggesting the time when the river will be turned into a series of rapids; but another silent cause is at work, and one not easily seen—namely, the effects of the changing of level of the earth's crust. From the computations already referred to it was found that for the first twenty-four thousand years of the life of the river only the Erie waters flowed by way of the Niagara River, and for only eight thousand years have all the waters of the upper lakes been feeding the falls. If the terrestrial movements continue as at present, and there appears no reason to doubt it, for the continent was formerly vastly higher than now, then in about five thousand years the rim of the Erie basin promises to be raised so high that all the waters of the upper lakes will flow out by way of the Chicago Canal. Thus the duration of Niagara Falls will have continued about thirty-seven thousand years. But the lakes will endure beyond the calculations of the boldest horologist.

RELATION OF THE FALLS TO THE ICE AGE.—In telling of the times of the great mutations in the physical history of the lake region, the story of Niagara Falls seems completed, but as a timepiece they are much more important in being used as a stepping stone back to the great period of frost which separated the former order of the continent from the modern. Having ascertained the approximate amount of the rising of the land recorded in the deserted beaches, before and since the birth of Niagara Falls, and the rate of the rising of the land, and applying it to the movement recorded in the abandoned shores, it is concluded that the epoch when the lake region formed great expansions of more or less open water commenced fifty or sixty thousand years since. Going so far back in time, other conditions may have obtained to vary the rate, but these have been allowed for as far as possible.

Beyond the lake epoch the vicissitudes between the periods of great regional submergence and the earlier high continental elevation of the ice age proper are apparent, but the events are certainly unexplained, for what was done by glacial action and what by waves has not been determined. Niagara Falls

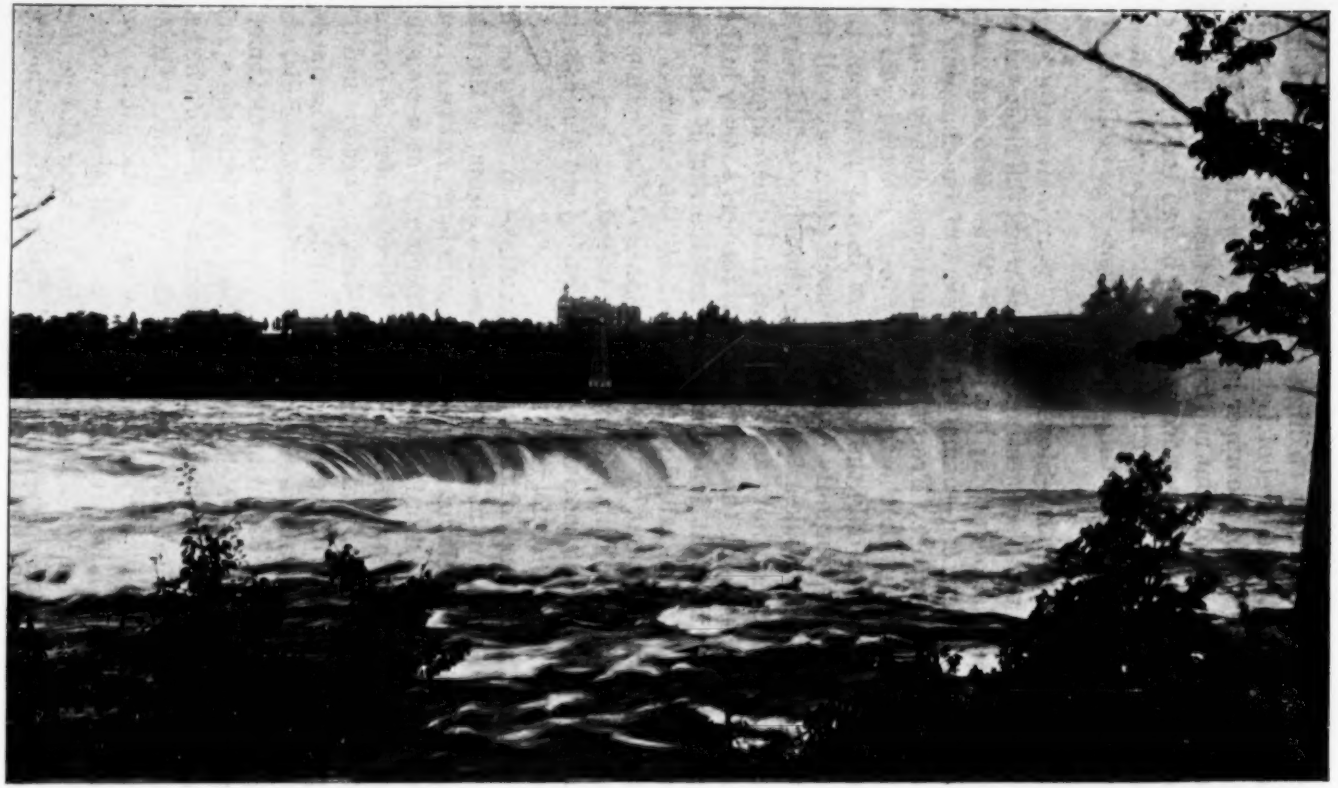

FIG. 17.—VIEW OF RAPIDS ABOVE THE FALLS AND OF HORSESHOE CASCADE; ALSO THE SAND TERRACE AND RIDGE OF TILL ON CANADIAN SIDE.

shows that the end of the Glacial period in the lake region was long ago.

How Niagara Falls may be used to ascertain the Antiquity of Man.—The relation of Niagara Falls to the deserted shores of the lake region and the high terraces is now pretty well known, and the old water margins have been traced over wide areas; but these may be much further extended and their relations to other regions beyond the drainage basins of the Great Lakes be ascertained, so that we may hope that Niagara Falls may be used as a means of at least roughly estimating the age of the deserted river banks on which the oldest inhabitants left their scanty treasures long ago. Concerning this application, it seems as only a question of the work of so many men and so much time.

To the geologist, the birth, life, and death of Niagara Falls show no more rapid changes than come within the limit of modern observations. There have been no sensational catastrophes, although in the popular mind these changes come with new and startling revelations, so that the most conservative observer may be surprised. The changes in the history of Niagara have now been told, so far as we know them. We can still watch the river performing its wonderful amount of work and the slow recession of the falls, as shown in Fig. 17.

If the reader of this sketch of the history of Niagara Falls desires the fuller information upon which this study is based, he is referred to Duration of Niagara Falls and the History of the Great Lakes, by the present writer, whose labors have been brought together by the Commissioners of Niagara Falls Reservation, under the presidency of the Hon. Andrew H. Green, whose liberal policy is not merely to preserve the falls as an international park, but to make known their scientific history.

In the ascension of the balloon Phenix, made from Stassfurt, Prussia, in December, 1894, the weather being misty at starting, the temperature at first increased up to a considerable height, but afterward fell, and at 32,150 feet stood at −20° C. At about 29,500 feet the balloon passed through a veil-like stratum of cirrus clouds, consisting of perfectly formed flakes of snow. At 31,500 feet the thermometer dropped to −54°, and indicated only −11° in the sun's rays. The highest temperature recorded was 43°. During the ascent of three hours and the descent of two hours and twenty minutes the balloon traveled one hundred and eighty-six miles, although it was almost calm at the surface.

Observing the growth of bamboos in the Botanical Garden of Buitenzorg, Java, Mr. Gregory Kraus noticed one plant which added to its length 22·9 centimetres a day for fifty-eight days. Another plant grew 19·9 centimetres, and a third nineteen centimetres a day for sixty days. The longest single day's growth observed was 42·45 centimetres.

THE DEVELOPMENT OF THE MONETARY PROBLEM.

By LOGAN G. McPHERSON.

THE consideration of every problem concerning the welfare of humanity compels, first, the understanding of what constitutes that welfare. That is, recognition must be had of the factors that forward civilization, which is the condition that permits the attainment by each individual of the highest harmonious, physical, mental, and moral development of which he is capable. To the highest physical life it is necessary that the body be nourished by a regular and sufficient supply of food; that it be protected by appropriate clothing and properly housed; that it receive the exercise and the care and attendance that contribute to the maintenance of the bodily functions. To attain the highest mental life it is necessary that knowledge of that which mankind has said and done shall be brought to the mind of each individual, to the extent that such knowledge will the more thoroughly adapt him to his environment and enable him to most effectively react upon that environment. In the agencies that lead to these ends—that is, in the production and distribution of food and clothing; in the erection and furnishing of houses; in the processes of manufacture that result in the various articles of personal use; in the production of newspapers, books, paintings, and statues; in the composition and rendition of music, and in all the other functions that contribute to bodily and mental welfare and gratification—are employed the efforts of by far the greater number of the adult male population and of a considerable number of the female population of the civilized world. As this effort is so interwoven that it is almost if not quite literally true that the work of all contributes to the welfare of each, and the work of each contributes to the welfare of all, it is manifest that there must be some means whereby the portion of welfare accruing to each individual from the totality of effort may be measured out to him, and as human effort has become the more closely interwoven has this means changed in becoming the more adapted to its purpose.

In prehistoric time, the man whose home was a cave, whose clothing was the untanned skins of beasts, and whose food their flesh and berries and fruit, knew not money and needed not money—the satisfaction of his wants resulted immediately and directly from his own exertion. And so likewise throughout the untold years during which he learned to cook with fire made by the spark of flint and to fashion the flint into spear heads, he needed not of the effort of others. But through the ages, as his developing brain led his hands to other uses, as he learned to

mold and harden the clay into pots, to fashion and wield the oar, to weave the bands of willow into mat and basket, it became impossible for any one man to accomplish for himself all that man had learned to do. There was division of labor, first perhaps between a man and the women of his household, but in time the efforts of the members of any one family alone became impossible to supply its wants. There was a further division of labor, and the exchange of the results of effort is the more marked as the division of labor increases. When one man traded pots of clay to another for flesh obtained in the chase, the efforts of the one in digging, molding, and baking were exchanged for the efforts of the other in hunting, killing, and delivering the game. This was barter and barter, or the exchange of effort as embodied in desired commodities, without the intervention of other commodities, endured over much of the earth for centuries, complicated by the customs of slavery, feudalism, and absolutism. But as man learned in a greater number of ways to produce a greater variety of articles, barter became inadequate to effect their exchange. A weaver might want a bow and a dozen arrows, and a maker of bows and arrows might want a bolt of cloth; but the weaver, perceiving that he had to work six days to make the cloth, while six bows and as many dozen arrows might be made in that time, of material no more difficult to obtain and by a man no more skillful than himself, would properly refuse to exchange the cloth for fewer than that number of bows and arrows—that is, a bolt of cloth would be worth six bows and six dozen arrows. If, however, the exchange were so made, the weaver would have five bows and five dozen arrows which he did not need. He, therefore, would not obtain the reward for his own use of his effort in producing the bolt of cloth until he had exchanged the five bows and five dozen arrows for articles that he could use. Consequently, if barter were persisted in, each purchaser would accumulate a number of articles of different kinds for which he had no need, and he might have no place wherein to store them. Each producer would be endeavoring to exchange articles made by every other producer, and so have his time absorbed that his efforts in production would be lessened. The process of exchange would be of inextricable confusion. If, however, there were some one commodity for which each producer would readily exchange his products at any time, so that, therefore, each person could at any time exchange this commodity for any other commodity that he might need, the process of exchange would be simplified. It is evident that such a commodity must occupy little space, so that it could be readily stored, that it must not be perishable, and that it must be so divisible that different portions of it might be exchanged for different commodities in proportion to their value—that is, in

proportion to such quantity of the commodity as might be accepted by the seller for and yielded by the buyer to obtain the article exchanged. Such a commodity used for the convenience of exchange is money; and all peoples who at different places on the earth's surface at different times have step by step risen from barbarism through barter have made use of money. Different commodities at different places and with different peoples have served for this purpose—skins with one tribe, shells with another, beads with another, and even in our own country, within the last two hundred years, the leaves of the tobacco plant. But no other substances known to man have so completely possessed the attributes of permanence of form, durability, and divisibility as the metals; and therefore lead, tin, copper, silver, and gold have been very extensively used as money.

Another characteristic essential for a commodity used as money is its acceptability, not only among the persons of a particular locality, whose efforts are interchanged, but among the people of all localities whose efforts are interchanged. The shells accepted by the members of one tribe might not be acceptable as money by the members of another tribe among whom skins were used for that purpose. If the members of the tribe using shells as money wove mats and molded pots, which were acceptable for exchange for tools made by the tribe using skins as money, and the money of neither tribe were acceptable to members of the other, there would be direct barter of the tools of one tribe for the mats and pots of the other. But as barter between individuals of one locality results in confusion, so also does barter between individuals of different localities, and the confusion in the processes of exchange by barter becomes the more inextricable as an increasing number of people in an increasing number of localities produce an increasing number of articles acceptable for exchange among the different peoples of the different localities. With the extension of intercourse between tribe and tribe, race and race, has therefore increased the tendency toward the use as money of commodities acceptable as money over the more extended territory occupied by the peoples whose efforts were interchanged. With the increase of this tendency the use of metals as money increased. They have been found in nearly all parts of the earth, and because of their general acceptability—that is, because of a certain common estimation in which they have been held—they have attained to a degree uniformity of value, which has the more nearly approximated perfect uniformity of value as the use of metals as money has become restricted to the metals meeting in greatest degree the requirements of money, which are silver and gold. And as the common needs of similarly situated groups of people have resulted in the formation of the more or

less coherent bodies known as states and nations, the use of gold and silver as money has the more extensively been sustained by coinage—that is, the weight and fineness, and therefore to a degree the value, of different portions of these metals have been evidenced by the stamp of the administrative bodies of states and nations, and this use of gold and silver has been enhanced by their exquisite luster.

As commodities were exchanged in larger volume, metals of the greatest value were coined. The extensions of intercourse between races incident to the conquests of Philip and Alexander were marked by the coinage of gold. At the time of the decemvirs, the Romans passed from barter to the use of copper coins; as their commerce increased, the southern settlements along the sea made use of silver, and, finally, after gold bullion had long been the medium of exchange in Eastern commerce, Julius Cæsar opened the mints to gold. After the submersion of the Roman Empire the coinage of gold was not resumed until the florin was issued at Florence in 1252—the extensive commerce initiated by the Crusades demanding a more valuable medium than silver.

The different weights, sizes, and shapes of coins made by different nations, the different units of value by which they have been measured, and the different languages in which their values have been expressed, have caused much confusion, as different tribes, races, and nations have passed beyond restricted intercourse between their own members to commercial intercourse one with the other, or rather, as individuals of particular tribes, races, and nations have undertaken commercial intercourse with individuals of other tribes, races, and nations. Hence the moneychangers of antiquity, the remote forerunners of bankers who arrange international exchanges to-day. With the combination and recombination of tribes and races under governments, whose administration has extended over considerable areas, the monetary systems have become correspondingly fewer—the imperial coinage of the German Empire supplanted seventy different coinage systems of the combined states—and coins of the different nations have the more nearly approached uniformity in shape, weight, size, and value.

But even the precious metals, although they satisfy the requirements for money better than any other commodities, do not meet those requirements in perfection.

In the first place, the amount of silver and gold in existence at any one time is never in the same proportion to the volume and value of the exchanges of that time as it is to the volume and value of exchanges at other times—that is, the volume of gold and silver does not expand and contract in exact accord with the expansion and contraction of commerce. Nor is it conceivable that

the rapidity of circulation of either gold or silver varies in exact ratio with the variations of trade. The growth of commerce, for example, that began in Europe during the thirteenth century, so far outstripped the increase in the supply of the precious metals that each of the petty states and principalities was in a continual fight with the others for the possession of a sufficient supply of gold and silver whereby the exchange of effort as evidenced by the exchange of commodities between its own subjects could be rewarded. The world's product of gold was nearly four times as great in 1850–'60 as during the preceding decade; it was about twenty-five per cent less in 1880–'90, and during the present decade promises to exceed that of 1880–'90 by one hundred per cent.

And the supply of neither metal increases in the same ratio as the other; therefore, that pursuit after a constant ratio between gold and silver which has continued to this day is vain as the cruise of the Flying Dutchman.

And as it is estimated that at the present time actual coin passes in less than ten per cent of the exchanges, it is significant that a medium of exchange has largely taken the place of coins. This medium consists of paper representatives of value.

And, again, the quantity even of gold necessary to effect any considerable exchange is of such weight that its transportation is a matter of inconvenience, and for any person or association of persons to keep safely on hand all the gold that might be amassed at any one time would necessitate expensive precaution. Obviously these inconveniences are avoided by the deposit of silver or gold coin or bullion in the charge of a person or persons responsible for its safe keeping, and for its transfer from the owner to another as he may direct. Hence banks of deposit and payment by check, the use as money of paper representatives of money. For if B is willing to accept the check of A upon banker C in the belief that he can obtain the money for which it calls upon presentation, why should not D accept the same check from B upon B's assurance that it is good?

If A, buying merchandise from B, says that he will have the money wherewith to pay for it when he has resold the merchandise, or at the end of a particular time, B may be willing to accept his written promise to pay; usually, however, with the stipulation that A surrender an additional sum as compensation to B for waiting for the payment. This sum is interest. And upon B's guarantee that the promise is good, D may be willing to accept the promise from B as payment for other merchandise. Or if B need the money in advance of the time specified in A's promise to pay, he may perhaps deliver the promise to D in return for the money. Or, as would be more likely, he would seek

to obtain the money from banker C in exchange for the promise of A guaranteed by himself. It is obvious that should D or banker C pay to B the full amount of money specified in the promise of A, he would be dispossessed thereof from the time it was given to B until it was repaid by B—that is, he would have rendered a service without compensation. It is equally obvious that compensation would be obtained if a portion of the sum specified in the promise were withheld by C. This sum is the discount. Banker C, by making a practice of thus advancing money on such promises, may obtain a considerable revenue. Hence banks of discount.

There are banks which not only make money by discounting from the amount of deposits over and above what they estimate will be required for daily needs, but which issue promises to pay in the form of bank notes, the funds available for use in discounting being, therefore, increased. Hence banks of circulation.

The development of banks, therefore, has been from simple repositories of the commodity used as a medium of exchange into purveyors of the currency that is superseding coin, the providers of funds for commercial transactions, and the centers through which instruments of exchange are balanced.

Besides the checks and promissory notes issued by individuals, which have a limited circulation, and the notes issued by banks, which have a more extended circulation, many governments issue notes directly that circulate generally among their peoples. As, however, the precious metals are the only commodities generally accepted as money throughout the world, all promises to pay are based upon one or another of them, but the aggregate of value represented by these promises to pay is so great that their fulfillment at any one time in coin or bullion would be impossible, the ratio between the volume of exchanges effected by the use of paper representatives of money to the volume effected by coin or bullion itself being, as has been said, greater than nine to one.

This fact, that the total value called for by the paper representatives of value at any time in existence, although expressed in terms of the units of value originally designating coins, vastly exceeds the value of the metals as coined or held in bullion by the sources whence coins are issued, together with the fact that no man willingly and knowingly exchanges commodities for paper representatives of value without believing that he can obtain the worth called for by these representatives, leads to the perception that, after all, it is not the metals, however precious, but property of all kinds that is their basis, and that these paper representatives of value are succeeding coins in designating and

measuring the value of the commodities for which they are exchanged. And as the value of commodities depends upon the efforts expended, under the law of supply and demand, in producing and delivering them at the place of need, the ultimate function of paper representatives of value is to measure and reward human effort.

By way of example, let it be supposed that a tailor sells a suit of clothes and receives in payment therefor a check for, say, fifty dollars. He deposits that check in a bank in the belief that he can obtain a definite worth for it in whatever commodities or services he may choose to invest it, and the bank likewise accepts and places it to his credit, in the belief in the ability of the signer and indorser to produce commodities or services of the value for which it calls. If the tailor buys a set of furniture and gives his check for fifty dollars therefor, what he has done has been to exchange the value of cloth as measured, cut, sewed, and trimmed into particular shape for timber, cut, joined, and varnished into a particular shape of what he deems an equal value. The value of the efforts of men expended in producing the clothes has been balanced against the value of the efforts of men expended in producing the furniture. If fifty dollars in coin were received for the clothes and given for the furniture, the effort expended in producing the clothes would be measured against the effort expended in producing the furniture, by the use of an intermediate commodity; if a check were received for the clothes and a check paid for the furniture, effort would be measured against effort by means of paper representatives of value through the agency of a bank. If the tailor, instead of purchasing furniture worth fifty dollars, purchases a number of articles aggregating fifty dollars in value, the result is the same. The efforts of men in producing the number of articles have been measured against the efforts of men in producing the suit of clothes, and this is the function performed by money in every exchange, whether great or small, and whether the money is coin or a paper representative of value. Effort as expressed by result is measured against other effort as expressed by other result.

The test of the efficiency of a paper representative of value, therefore, is the extent to which it can be exchanged for the value which it expresses. But as the value of a paper representative of value is expressed in terms that also express the value of coins, it is a measure of so much value as is represented by the coins, and a paper representative of value is at present almost universally considered as such only to the extent that it is the representative of coin. A certain amount of coin, or the bullion from which it is derived, has a definite and known value

as coin or bullion, without qualification or condition, throughout civilization, but a piece of paper representing the value of that amount of coin or bullion considered simply as paper, whether covered by writing or impressed by an engraved block, is without intrinsic value. That is, for example, twenty-nine grammes, 448·025 grains, of fine gold, whether in bullion or coined into a hundred-franc piece, can readily be exchanged throughout Europe and almost as readily throughout America for an approximately similar amount of commodities; but a piece of paper known as a National Bank of Belgium one-hundred-franc note can be exchanged for commodities to this value only among peoples who feel confident that it can readily be exchanged again in return for commodities to the value of one hundred francs, and such peoples in great numbers do not exist outside the kingdom of Belgium, because other than the Belgian people are not generally familiar with the language in which the note is printed, and therefore do not understand the value of the units of value in which the note is expressed, and they are not sufficiently familiar with the Belgian banking system to know that the note is secure—that is, that twenty-nine grammes, 448·025 grains, of fine gold, can readily be obtained for it. The extent to which a paper representative of valuo, which in itself has no intrinsic value as a commodity, will circulate is therefore at present determined by the number of people who believe that it can readily be exchanged for coin or bullion to the value expressed by it. Essential to this belief are confidence in the honesty and ability of the issuer. Therefore, when a people among whom paper representatives of money of a particular issue have been freely circulating begin to lose confidence in their ability to readily exchange them for the coin for which they call, there arises a tendency to exchange commodities and services only for coin. As this tendency increases, as the lack of confidence in the paper grows, there is soon reached a time when the exchange of commodities and services is greatly diminished, because there is only sufficient coin in existence to effect a small fraction of the normal value of exchanges.

But, as measures of value in the last analysis are measures of human effort as determined by its results, it is obvious that, were every paper representative of value so secured that the holder thereof might be certain that at any time he could obtain in exchange for it the result of human effort to the measure of the value called for by it, in a form acceptable to him, such paper representatives of value would obtain free and general circulation among all people believing in their security. The more extended the territory throughout which, and the greater the number of people among whom, such a currency would circulate, the less

would be the need over such territory for the use of bullion or coin as money or the basis of paper representatives of value. And the monetary systems of the peoples among whom commerce has obtained the greatest development are gradually reaching such a basis. The paper representatives of value, which at first were direct representatives of coin, are tending more and more to become the representatives of value, as expressed by the result of effort, without the intervention of coin, and in the furtherance of this tendency banks perform an essential part. In the evolution of the social organism banks become the ganglia through which the action of the different parts of the organism is measured and made reciprocal.

And as the use of bank notes, checks, bills of exchange, government notes, and other paper representatives of value is most marked among the peoples through whose exertions commerce has attained its highest development, so also the members of a highly civilized community most concerned in commerce make greater use of these paper representatives of value than other members of such a community. In any large city the transactions of the principal manufacturers and merchants are chiefly conducted by means of checks, bills, and notes, while clerks, artisans, and laborers, who are principally paid in coin or the direct representatives of coin, secure needed commodities by the immediate exchange of coin or the direct representatives of coin for them. The development of representatives of value not based upon coin to the extent of rendering them generally acceptable for exchange among clerks, artisans, and laborers would still further decrease the dependence upon coin or bullion as money or the basis of money, leaving coin and bullion freer for use in effecting exchanges between peoples of different nationalities who are so separated by language, habits, or institutions that commercial intercourse between them must be upon a bullion basis.

ONE of the incidents of the recent deep-sea dredging expedition of the Prince of Monaco most fruitful in scientific results was the capture of a sperm whale. It occurring to the prince that the food collections in the animal's stomach might include specimens of creatures still unknown, the ship was held near the whale till it died. In its convulsions it threw up a mass of fragments of very curious cephalopods, which were beginning to float away and be scattered and lost to science, when the ship's screw was reversed to create a counter current, under the advantage of which specimens of two entirely new species, quite different from any hitherto known, were recovered. The body of one was covered with scales, and was more than ninety centimetres long. The other had a crown of tentacles armed with suckers bearing claws like those of the larger birds of prey.

PRINCIPLES OF TAXATION.

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II.—THE PLACE OF TAXATION IN LITERATURE AND HISTORY. PART IV.

TAXATION IN FRANCE.—No chapter in history is more replete with interest and instruction than that which exhibits the system for exacting contributions for the support of the state which characterized the fiscal policy and administration of France during the seventeenth and eighteenth centuries, and which is now acknowledged to have been mainly instrumental in bringing on the memorable revolution in the closing years of the latter century.

Feudalism in France, previous to 1789, had come to find its expression almost exclusively, in the claims on the part of the various and multiplied representatives of authority—nobility and clergy—to regulate taxation, in respect to both imposition and exemption.

The kingdom was divided into departments, with an officer called an "intendant," or "farmer-general" (*fermier général*) at the head of each, into whose hands the whole power of the crown in respect to revenue matters was delegated. Each department was then sub-divided, and at the head of each of these subdivisions a deputy was appointed by the intendant. The rolls or lists of the various crown taxes, for polls, service, incomes, "proportions," and the like, were distributed by the intendants to their deputies, who had the power to exempt, change, add to, or diminish the list at their pleasure.

It must be obvious, that the friends of the intendant and of all his deputies, and the friends of their friends, might be favored at the expense of the helpless masses; and that great noblemen in favor at the court, to whom the intendant himself would naturally look for protection, would especially find little difficulty in transferring most or all of the burden of tribute rightfully due from them to the state, to others who had no such influence. The result was that taxation in France at the period mentioned had become in the highest degree arbitrary, and a scarcely disguised form of plunder; and the methods of assessment were so crude and defective that it is probable that the state never received fifty per cent of the amount collected, and in many cases no more than forty or thirty per cent. The expenditures of the revenues received were, moreover, characterized by so little system as to render it difficult to exercise any efficient check

upon them, or to ascertain accurately at any one time (as was especially the case during the latter third of the eighteenth century) the true state of the national exchequer; all of which fostered indefensible waste and extravagance. At the death of Louis XV in 1774, the annual expenditure of the king and his household probably amounted to one eighth of the entire revenue of the state,* and the total indebtedness of the state in 1789, the year of the commencement of the revolution, was estimated as being in excess of $1,000,000,000, carrying an annual interest of $206,000,000; and it is to be remembered that these figures must be at least doubled to represent the corresponding sums of the present day. All this indebtedness, and all that was subsequently incurred through the issue of irredeemable "assignats" (paper or fiat money), was ultimately, through one means or another, entirely repudiated.

In the collection of levies the inquisitorial, infinitesimal assessment and dooming penalty system, the like of which still finds favor in Massachusetts, was carried out to perfection; and the only rule of practice which in different districts could prefer any claim to uniformity, was the rule of inequality of assessment, and harshness and cruelty in collection. Arthur Young, an English gentleman of culture and keen powers of observation, who traveled in France in 1787–'89, states, in recording the above experiences, that "he shuddered at the oppression of which he became cognizant."

One of the chief sources of revenue to the state was from an exaction known as the *taille*,† which was mainly in the nature of a direct tax on land, though in some provinces it was a levy on both polls and land. The history of this exaction has been carefully investigated and is not a little interesting. It originated in the early feudal period, and was imposed on persons originally bondsmen, or on persons who held in "*farm*," or *lease*, or resided on the lands of a noble or suzerain, and from which the proprietors or suzerains of the land were exempt. And as no vassal could at will divest himself of servitude or allegiance to his lord or suzerain, so the obligation to pay tribute (taxes ?) always remained upon him as a personal servitude, wherever he might be In other words, the condition of the masses in France during the middle ages was not unlike the condition of the slaves in the United States previous to emancipation. These had property in

* There were seventy-five officers connected with the king's chapel alone; forty-eight physicians, surgeons, and apothecaries attached to his person; and three hundred and eighty-three men and one hundred and thirty-three boys employed for his table.

† The *taille* was the equivalent of the English "tallage." But the discretionary power of levying the impost was taken away from the English crown and nobility by the provisions of Magna Charta.

their possession, and spoke of themselves as owners of property, but in reality their property followed the condition of the servitude of their persons, and both persons and property belonged equally to the masters. The *taille*, furthermore, as a badge of servitude, was supposed to dishonor whoever was subject to it, and degrade him not only below the rank of a gentleman, but of that of a "burgher," or inhabitant of a borough or town; "and no gentleman, or even any burgher," writes Adam Smith in 1775, "will submit to this degradation."

(Repulsive and barbarous as was the *taille*, it is curious to note that the principle involved in it still survives and finds recognition and practice in States claiming a high civilization; as, for example, in Massachusetts and Connecticut, where personal property is held to owe a servitude to the State and to be subject to taxation by it in virtue of the citizenship or personal domicile of its owner, although the property itself may be located beyond the territory and jurisdiction of the taxing power.)

The hardship and injustice of the practical working of the *taille* may be thus illustrated: In all cases the nobility and the clergy were exempt from its payment, as were also the holders of a multitude of minor Government offices, which, however, did not carry with them any patent of nobility. These exempt classes, which in the time of Louis XVI are believed to have numbered some 300,000 out of a total estimated population of 25,000,000 in the kingdom, owned about one half of the whole soil of France; so that the burden of the *taille*, amounting in 1789 to 110,000,000 livres (francs), fell exclusively on the rural classes; especially upon the agricultural interests, which it would have been sound policy on the part of the State to favor.

"But the mode in which the *taille* was levied still further illustrates its iniquity. The Comptroller-General of the Finances, in the first instance, decreed that a certain aggregate sum was to be raised, and then two subordinate officials and the local landlords in each province and parish were left to decide among themselves how the prescribed amount was to be exacted from the taxpayers. The combined forces of jobbery and absolute authority rendered its incidence grossly unfair, the poorer localities generally paying the larger share, while the richer ones escaped lightly. Thus there was brought about a condition of things in which the most miserable sections of the community were made to feel their inferiority in every relation of life. They were humbled in all their feelings, and they could not but loathe those whom birth or favoritism had placed above them." *

Besides the *taille*, two other forms of direct exaction were in-

* The Financial Causes of the French Revolution. By Ferdinand Rothschild.

cluded in the fiscal policy of France at the period under consideration—namely, a so-called capitation tax, which was a kind of graduated tax on capital, and from the incidence of which there was theoretically no exemption; and the *vingtième* (one twentieth), instituted by Colbert, which was an income tax, and supposed to be levied on every class. Owing, however, to inefficient administration, and to the circumstance that the clergy occasionally bought exemption for themselves for a term of years by the payment of a lump sum, the revenue derived from these sources was always much less than it ought to have been, the privileged class to a large extent evading assessments.

The almost complete exemption of the clergy of France during the ante-revolutionary period from taxation, whereby those who were supposed to preach and practice charity were so intent upon securing worldly vantage as to have thrown nearly all their duties and responsibilities to the state upon the poor, constitutes one of those striking contradictions which so often confront us in history.

The indirect taxes were very numerous; comprising the customs, the octroi, the excise, and special taxes on wines, cards, tobacco, salt, and on a great variety of manufactured products; and in their collection the arbitrary, inquisitorial, infinitesimal, and penalty system was carried out to perfection. It was this class of taxes which undoubtedly pressed most heavily on the French poor, and from the direct incidence of which the Church and nobility managed in a great degree to escape. Very curiously, also, they constituted an inducement to the peasantry to seem poorer than perhaps they actually were, and to live in low, thatched cottages, without floors or glass in the windows, inasmuch as any improvement of their dwellings meant an increase of their taxes. Custom duties were levied, not only at frontiers of the kingdom, but between every province of France. The *taille* was exacted with military severity. "Carriages and carts were stopped on the highway and searched by the tax collectors; no private house was safe from them by day or by night; and on the slightest suspicion they used the power of arrest that was vested in them. Prosecutions for unpaid taxes were carried on with the utmost rigor. The clothes of the poor were seized, and even their last measure of flour, and the latches on their doors. Collectors, accompanied by locksmiths, forced open doors and carried away and sold furniture for one quarter of its value, the expenses exceeding the amount of the tax."—*Taine.*

The most vexatious, arbitrary, and extraordinary tax of this period was that imposed on salt, and known as the "*gabelle*"; and to one who now acquaints himself with its history and details it must seem almost inconceivable that any country claiming to

be civilized ever could have had such an experience. In order to effectually secure at the outset the payment of this tax, the right to produce and sell salt was vested exclusively in the state. By an ordinance in 1780, every person over seven years of age was required to purchase, not at convenience, but on one stated day of each year, seven pounds of salt, which in a peasant's family of four, according to Taine, entailed an expense equal to the average wage receipts of nineteen days' work. It was forbidden also to divert a single ounce of the seven obligatory pounds to any use but the "pot and the salt cellar." If any one failed in these observances he was fined; and he was also fined if he purchased a smaller quantity than the law prescribed. To supplement the use of salt with water from the ocean, or from saline springs, or to water cattle in marshes or other places containing salt, was forbidden under severe penalties. In certain departments of France it was also made incumbent on officials periodically to destroy, often by defilement, all deposits of salt which were formed naturally. No retail dealing in salt was permitted, but Government warehouses were established, often at places at considerable distances from towns and villages, where their inhabitants were compelled to make their purchases. According to a report made by the comptroller-general in 1787, the salt tax at that time annually occasioned "four thousand domiciliary seizures, three thousand four hundred imprisonments, and five hundred sentences to flogging, exile, and the galleys."

But in addition to the so-called national system, which imposed a great variety of taxes upon all persons and property in France which could not through favor procure exemption, which exemption embraced practically all the nobility, clergy, and gentry, there were a great number of taxes peculiar to separate estates or seigniories, but at the same time more or less general. Thus, all the various operations involved in production and consumption were made, as far as possible, the occasion for tax assessments. The tenants, or vassals, were bound to grind their corn at the mill of the seigneur only; to bake their bread exclusively at his ovens; to press their grapes and apples exclusively at his presses; and for every such industrial conversion a toll or tithe was collected. One of the memoirs touching the condition of the Tiers État, as the common people were called, published about the time of the meeting of the National Convention, expresses a hope that posterity may be ignorant that feudal tyranny in Brittany, armed with judicial power, did not blush at breaking hand mills and selling annually to the miserable people the privilege of bruising between two stones a measure of buckwheat or barley.

Movements of persons or property from one town or parish to

another always involved taxation. If a farmer or laborer moved from one parish to another, it was held that he could not separate himself from a residence once adopted, but remained there for taxation, although he might actually and permanently have left it and be paying taxes in another place. All movements of property and persons were discouraged; and it not infrequently happened that there was grievous famine in some departments of France, and a surplus of food at the same time in others, not very far distant, because of the inability of producers in the latter to dispose of an abundant harvest for lack of any remunerative market or demand. Every sale or transfer of property also carried in it a payment to the seignior, or lord of the manor, to the extent of one eighth and sometimes one sixth of the entire equivalent received in consideration. And it is interesting here to note that this exaction was recognized and enforced in French Canada until the abolition of seignioral tenure, forty years ago. Arthur Young states that at the time he traveled in France, 1787–'89, the very terms used to designate the taxes imposed on the peasantry were in many instances untranslatable into English; and from a long list of such terms as he recorded, very few can be found and defined in any ordinary French lexicon.* In order, however, in some degree to satisfy curiosity as to the nature of these abominations, it may be mentioned that one of the local taxes in Brittany, which remained in force down to 1789, and was known as the "*silence des grenouilles*," was a money payment in lieu of an ancient feudal obligation incumbent on the residents of marshy districts to keep the frogs still, by beating the waters, that the lady of the seigneur might not be disturbed "when she lies in"; while another exaction, still more outrageous, which was not repealed until the French revolutionary convention in 1790 swept it from the statute book, was a tax known as *cuissage*, or "*droit du seigneur*," which was paid to the seignior as a substitute for his ancient and formerly undisputed right to the possession before marriage of the person of every female, the daughter of any of his serfs or more dependent vassals.†

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* Of such terms Mr. Young mentions the following as expressive of the tortures of the peasantry in Bretagne (Brittany) without attempting to define their exact meaning: "*Chevauches, quintaines, soule, saut de poisson, baiser de marices, chansons, transport d'œuf un charrette, silence des grenouilles, corvée à miséricordes, milods, leide, couponage, cartilage, borage, fouage, marechaussée, ban vin, ban d'aout, trousses, gelinage, civerage, taillabilité, vingtain, sterlage, bordelage, minage, ban de vendanges, droit d'accapite*," etc.

† This exaction, the reality of which has been called in question, would seem to be a necessary incidence or outcome of slavery or serfdom, inasmuch as the condition of slavery implies no rights on the part of a slave that the master is bound to respect. Mr. Thorold Rogers is authority for the fact that this *droit du seigneur* was recognized under

Another relic of old feudalism which prevailed in France down to the period of the Revolution, and which, indirectly a tax, was most oppressive and impoverishing to the French rural population, was an obligation termed the *corvée*, imposed upon them to keep the main roads of the kingdom in repair without being remunerated for their labor or for the services of their animals. They were thus frequently forced away with their teams from their fields, at the demand of any traveling noble or important personage in either church or state, and often at a time of sowing or harvesting, when they could be least spared; and were occasionally required to travel long distances in order to reach their allotted work. While they were thus compelled to keep the main roads of the kingdom in repair, which were generally of little use to them, the local or parish roads, on which they were dependent for their communication with adjacent towns or villages, were allowed by the Government to remain neglected.* For many years previous to the Revolution, the institution of the *corvée* undoubtedly meant to the French peasantry a period every year of from twelve to fifteen days of forced labor for the construction and repair of roads, for which the nobility, clergy, and town merchants contributed not a sou, or an hour of work.

And now comes an exceedingly interesting but little-known chapter in French history. There were men of large hearts and great intelligence in France during the reign of Louis XIV—1643–1715—who were not only keenly appreciative of the oppressions and sufferings of the French people by reason of their horrible system of taxation, but also of the certain destructive influence of this system on the industry, society, and government of the kingdom.† Among these was the celebrated Marshal Vauban, who, although a soldier by profession, and holding one of the highest offices among the privileged nobility, had made a study of the misery of his countrymen, and had discerned in a great degree its cause, and was seeking for its remedy. The knowledge that his office as marshal of France gave him of the necessity for great expenditures—the country being almost always at war—and the little hope he had that the king would retrench in matters of splendor and amusement, left him no other alternative but to try

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various names, as *jambage*, *mercheta*, and *mantagium*, in France in the thirteenth and fifteenth centuries, and that fines in recognition and in lieu of this ancient manorial right were probably paid in England almost as late as the administration of Cromwell.

* This practice or institution of the *corvée* was undoubtedly of ancient Eastern origin, and until recently existed in Egypt; a very considerable part of the labor employed in constructing the Suez Canal having been performed, in accordance with the orders of the then ruling Khedive, under its conditions.

† During the eighteenth century famine periodically decimated the rural population of France, and forty million acres went out of cultivation.

to find some method by which the burden of the multitudinous taxes imposed for defraying these expenditures might not be enormously and unnecessarily augmented by their method of taking. He accordingly proposed what was in effect a *single tax*—namely, that the king should annually take by one act or payment a royal tithe or tenth—*dixme royale*—of all the property of each community, or of each person in the kingdom; and that this simple and sole tax, which would suffice for all, and which would pass directly into the coffers of the king, should be the means by which every other form of tax or exaction from the people, with all its complicated, inquisitorial machinery for collection, should be abolished. About the same time a lieutenant-general of France—one Boisguilbert, of Rouen—took up the investigation of the same subject, and published a really learned and profound book; in which he also proposed a new system of taxation, which he claimed would at once relieve the people of many taxes, and the state of the necessity of great expenditure, by providing that the proceeds of every tax should go at once into the treasury of the king, instead of enriching first the farmers-general, the finance ministers, and their deputies.

The system of Boisguilbert was analogous to that proposed by Vauban, with the exception that the former advocated the continuance of some taxes on foreign commerce and upon foods, and the latter desired especially to abolish all such forms of taxation.

Admirable in many respects as were these proposed reforms; clearly based as they undoubtedly were upon what are now recognized as sound economic principles, they had one great defect. They prescribed a course which if followed would have taken away the means of livelihood of a very large number of officials. It would have compelled them to live at their own expense, instead of at the expense of the public. This was enough to insure their failure. All the people whose interests, fortunes, and emoluments were threatened arrayed themselves in opposition; for they reasoned truly that place, power, wealth, and social position would fly from their grasp if the counsels of Vauban were to be followed. It is not to be wondered, then, that the king listened to the advice of the multitude who were privileged to talk with him, rather than to his one clear-headed, unselfish, faithful servitor; or that when Marshal Vauban presented him with a book embodying and explaining his fiscal views and system, he received it with a very ill grace. His ministers also, even if they were contrary disposed, which is not probable, could not do otherwise than follow the views of the king, and from that moment the splendid services of the marshal, his military genius, his virtues, the former affection the king had had for him—all were forgotten. He stood in the position of one courting the favor of the people, and con-

temning and weakening lawful authority. The circulation of his book was forbidden, and all the copies which the state could reach were destroyed; while the unhappy marshal, unable to survive the loss of the king's favor, or stand up against the enmities he had created, soon died of a broken heart.

His friend Boisguilbert, whom these events ought to have made prudent, could not restrain himself, but published a book vindicating Vauban, and answering one of the principal objections to his system—namely, the impracticability of making any radical changes during a great war—by asking if it was necessary to wait for peace before abolishing great abuses. This was a more offensive contemning of authority than Vauban had committed; and Boisguilbert was stripped of his functions, severely reprimanded, and sent into exile. For this he was in a degree recompensed by the acclamations and approbation of the people wherever he went.

The system and abuses which Vauban and Boisguilbert endeavored to reform accordingly continued; but as years went on, and the misfortunes of France accumulated and culminated in the total defeat of her armies by Marlborough, the necessity of larger revenues to meet larger expenditures became most urgent; but how to provide them was a problem which brought no little embarrassment to Louis XIV's ministers. At last Desmarets, who was Comptroller-General of the Finances, proposed to the Council of State, as a way out of their difficulties, that they should, *in addition* to all existing numerous and abominable taxes, establish or take on the system of a royal tenth, which had been proposed by Vauban and Boisguilbert as a substitute for all other taxes; with all the new machinery, officials, and valuations which such a system entailed. The proposition, after a brief consideration, was approved by the Council, and Desmarets was authorized to present it to the king; who, although long accustomed to various and extravagant exactions, is related at first to have been greatly terrified, and to have exhibited for some eight or ten days a profound melancholy. At the expiration of this period he regained his usual calmness, and gave the following explanation of the cause of his trouble: He said that he had been much tormented that the extremity of his affairs required him to take so much of the wealth of his subjects; and that at last he unbosomed himself to the Père Tellier (his confessor); who after a few days returned and reported that he had laid the matter before the most eminent doctors (theologians) of the Sorbonne, by whom it was decided, *that all the wealth of his subjects was the king's, and that when he took of it he only took what belonged to him.* The king added that this decision had taken away all his scruples, and had restored to him all the calm and cheerfulness that he had lost. After

the king had been thus satisfied by his confessor, no time was lost in establishing the tax. The effect upon the masses was one of great sadness, but there was no revolt. Many of the property holders in the kingdom endeavored to convince the state officials that under the former condition of affairs they did not enjoy a tenth part of their income, and representatives of the province of Languedoc offered to give up its entire wealth to the crown, if they might be allowed to enjoy, free of every tax, the tenth part of it. All these remonstrances and propositions were not only *not* listened to, but their presentation was regarded in the light of insubordination.

The product of this new tax was not nearly so much as had been expected; and its most marked result was, that it enabled the king to augment all his infantry to the extent of five men per company.

In this record of tax experience, which, commencing at least as far back as 1667, under Louis XIV, continued with increasing popular oppression and misery until 1789, we find the origin and the horrors of the French Revolution which began in the latter year. During its continuance six thousand persons, mostly of the ranks of the nobility, clergy, and gentry, are said to have perished under the hands of public executioners and upon the scaffold. But when one calls to mind the multitudes that, for many successive generations, were starved and tortured out of existence by a system of exactions under the name of taxation, and for which system the king, the nobility, the clergy, and the influential classes of France were responsible, the wonder is, that the masses of a brutalized and infuriated people should have shown so much clemency and restraint in the hour of their vengeance and of triumph.*

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* On this point, Arthur Young, whose observations on the condition of the French people were made before the great revolution had culminated, or in 1789, writes: "It is impossible to justify the excesses of the people or their taking of arms. They were clearly guilty of great cruelties. But is it really the people to whom we are to impute the whole, or to their oppressors, who had kept them so long in a state of bondage? He who chooses to be served by slaves, and by ill-treated slaves, must know that he holds both his property and life by a tenure far different from those who prefer the service of well-treated freemen; and he who dines to the music of groaning sufferers, must not, in the moment of insurrection, complain that his daughters are ravished and then destroyed, and that his sons' throats are cut. When such evils happen they surely are more imputable to the tyranny of the master than to the cruelty of the servant. The analogy holds with the French peasants. The murder of a seigneur, or a château in flames, is recorded in every newspaper. The rank of the person who suffers attracts notice. But where do we find the register of that seigneur's oppressions of his peasantry, and his exactions of feudal service from those whose children were dying around them for want of bread? Where do we find the minutes that assigned these starving wretches to be fleeced by impositions, and a mockery in the seigneural court? Who gives us the award of the intendant and his sub-delegues, who

It is interesting also to note in this connection that against no one class, when the revolutionary element became ascendant in France, was popular hatred more intense than to the farmers-general, to whom the collection of taxes in the different provinces of the kingdom was farmed out or contracted. The extravagant expenditure which, as a rule, characterized their living, was regarded by the masses as all-sufficient evidence of the enormous profits unjustly accruing to them from these contracts; and the power continually exercised by their agents to make domiciliary visits, seize goods, inflict fines, and take other measures of an arbitrary, obnoxious character to enforce compliance with extortions, all contributed to make them objects of execration by nearly the entire people. And this animosity under the revolutionary government speedily manifested itself, by sending thirty-two out of the whole number—sixty—of these high officials to the guillotine; among whom were undoubtedly some honest and conscientious financiers and otherwise distinguished men, such as Lavoisier, the father of modern chemistry.

One of the great results of the French Revolution, which ought to be duly weighed in reckoning up the good and evil of that mighty popular convulsion, is that it swept away the feudal land laws of old France and made landowners of several millions of men who were formerly serfs. Fully one half of the land of France at the present time is owned by small farmers or peasants; and in their hands has been demonstrated afresh what Arthur Young called the magic power of property to turn sand to gold. Regions which he visited in 1788, and found barren and deserted, a hundred years later were clothed with vines and gardens under the tillage of peasant proprietors.

From the foregoing consideration of France in the last century, experiencing through the abuse of taxation the most awful revolution in history, let us turn to a country of our own time and continent, and observe methods of taxation yet surviving the vigor and barbarism of the mediæval period.

TAXATION IN MEXICO.—Until recently, and to a great extent at present, the system of taxation operative in Mexico, the origin or evolution of which may in no small part be attributed to a sparseness of population, lack of accumulated wealth or capital, limited wants, and low civilization of the masses, is especially worthy of notice, and most instructive from the circumstance that nothing like it exists in any other country.

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took off the taxes from the man of fashion, and laid them with accumulated weight on the poor who were so unfortunate as to be his neighbors? Who has dwelt sufficiently on explaining all the ramifications of despotism, regal, aristocratical, and ecclesiastical, pervading the whole mass of the people, reaching like a circulating fluid the most distant capillary tubes of poverty and wretchedness?"—*Young's Travels in France.*

The duties levied on imports into Mexico are so excessive that the *average* rate of the Mexican tariff is probably greater than that adopted by any other country claiming to be civilized, with the possible exception of Russia. The favorite modern idea of making the tariff subserve two purposes—namely, the raising of revenue and the regulation of trade—does not appear as yet to have greatly interested either the people or Government of Mexico, as revenue, through the necessities of the state, is the supreme consideration; and for securing this no other rule seems to have been recognized and followed in imposing duties on imports than that the higher the duty (or tax) the greater will be the accruing revenue.

But with this general characterization of the Mexican tariff there comes in the following other most anomalous feature: Thus, in all commercial countries, save those which permit the levy by certain municipalities of the so-called *octroi* taxes, when foreign articles or merchandise have once satisfied all customs requirements at a port, or place of entry, and have been permitted to pass the frontier, they are exempted from any further taxation *as imports* so long as they retain such a distinctive character. In the United States, for example, it is held that the right to import carries with it a right to sell (i. e., in the original packages) without further restrictions. And the Supreme Court of the United States has decided that a license tax imposed by a State of the Federal Union, as a prerequisite to the right to sell an imported article, is equivalent to a duty on imports, and in violation of the provision of the Federal Constitution which prohibits the States from imposing import duties; and this decision has been carefully recognized by the authorities of the several States in dealing with imported liquors under local license, or other restrictive laws.

But, in Mexico, each State of the republic has had practically its own custom-house system, and levies taxes on all goods—domestic and foreign—passing into its territory for the purpose of use or consumption; and then, in turn, the several towns of the States again assess all goods entering their respective precincts. The rate of State taxation, being determined by the several State legislatures, varies, and varies continually, with each State. In the Federal District—i. e., the city of Mexico—the rate was recently two per cent of the national tariff; but in the adjoining State of Hidalgo it was ten per cent, and in others it has been as high as sixteen per cent. The rate levied by the towns is said to be about nine per cent of what the State has exacted; but in this there is no common rule. Nor is this all. For the transit of every territorial boundary necessitates inspection, assessment, the preparation of bills of charges, and permits for entry; and all these trans-

actions and papers involve the payment of fees, or the purchase and affixing of stamps. Thus, by section 377 of the tariff law of December, 1884, it is ordained that "the custom house shall give to every individual who makes any importation, upon the payment of duties, a certificate of the sum paid, which certificate, on being presented to the administrator of the stamp office in the place of importation, shall be changed for an equal amount in custom-house stamps. For this operation the interested party shall pay, to the administrator of whom he received the stamps, two per cent in money (coin) of the total value of the stamps." All imports into Mexico are liable, therefore, to these multiple assessments; and the extent to which they act as a prohibition on trade may be best illustrated by a practical example.

In 1885 an American gentleman, residing in the city of Mexico as the representative of certain New England business interests, with a view of increasing his personal comfort, induced the landlady of the hotel where he resided (who, although by birth a Mexican, was of Scotch parentage) to order from St. Louis an American cooking stove, with its customary adjuncts of pipes, kettles, pans, etc. In due time the stove arrived; and the following is an exact transcript of the bills contingent, which were rendered and paid upon its delivery:

ORIGINAL INVOICE:			
1 stove	weight 282 pounds.		
1 box pipe	" 69 "		
1 box stove furniture	" 86 "		
Total	437 pounds, or 199·3 kilos.		
Cost in St. Louis, United States currency		$26 50	
Exchange at 20 per cent		5 30	
Total		$31 80	
Freight from St. Louis to city of Mexico (rail), at $3.15 per 100 pounds		$15 75	
Mexican consular fee at El Paso		4 85	
Stamps at El Paso		45	
Cartage and labor on boxes examined by custom house at El Paso		50	
Forwarding commission, El Paso		2 00	
Exchange 16⅔ per cent on $7.64 freight advanced by Mexican Central Railroad		1 25	
			$56 60
IMPORT DUTIES:			
1 box, 128 kilos (stove), iron, without brass or copper ornaments, at 19 cents per kilo		$24 42	
1 box, 31·3 kilos, iron pipe, at 24 cents per kilo		7 51	
1 box iron pots, with brass handles, at 24 cents per kilo		9 48	
		$41 41	
Add 4 per cent as per tariff		1 65	
		$43 06	
Package duty, 50 cents per 100 kilos		1 00	
		$44 06	

Add 5 per cent as per tariff	$2 20	
	$46 26	
Add 2 per cent municipal duty	93	
	$47 19	
Add 5 per cent consumption duty	2 36	
	$49 55	
Dispatch of goods at Buena Vista station, city of Mexico	38	
Stamps for permit	50	
		$50 43
		$107 03
Cartage in city of Mexico		75
Total		$107 78

Résumé:

Original cost of stove, with exchange	$31 80
Freight, consular fees, and forwarding	24 80
Import duties	50 43
Cartage	75
Total	$107 78

Under such a system articles of the most common use in the United States are from their increase of price necessarily made articles of luxury.

Again, the Mexican tariff provides that the effects of immigrants shall be admitted free. "But this is rendered practically a dead letter, from the fact that the interior duties are levied on everything the immigrant has before he gets settled; and these are so heavy that immigration has been greatly discouraged. A carpenter, or other mechanic, who desires to get employment in Mexico, has such heavy duties levied on his tools on passing the national or State frontiers that few are willing or able to pay them. Hence, few American mechanics find their way into the country, unless in accordance with special contract."

The existence in a state of the New World of a system of taxation so antagonistic to all modern ideas, and so destructive of all commercial freedom, is certainly very curious, and prompts to the following reflections: First, how great were the wisdom and foresight of the framers of the Constitution of the United States in providing, at the very commencement of the Federal Union, that no power to tax in this manner, and for their own use or benefit, should ever be permitted to the States that might compose it (Article I, section 10). Second, how did such a system come to be ingrafted on Mexico, for it is not a modern contrivance? All are agreed that it is an old-time practice and a legacy of Spanish domination. But, further than this, may it not be another of those numerous relics of European mediævalism which, having utterly disappeared in the countries of their origin, seem to have become embalmed, as it were, in what were the old Spanish

provinces of America—a system filtered down through Spanish traditions from the times when the imposition of taxes and the regulation of local trade were regarded by cities and communities in the light of an affirmation of their right to self-government, and as a barrier against feudal interference and tyranny; and when the idea of protecting industry through like devices was not limited as now to international commerce, but was made applicable to the commercial intercourse of cities and communities of the same country, and even to separate trades or "guilds" of the same city? Whether such speculations have any warrant in fact or not, it is at least certain that we have in the Mexico of to-day a perfect example of what was common in Europe in the middle ages; namely, of protection to separate interests (through taxation) carried out to its fullest and logical extent, and also of its commercial and industrial consequences.

So much for the tariff system of Mexico and its adjuncts. The "excise" or "internal revenue" system of the country is no less extraordinary. It is essentially a tax on sales, collected in great part through the agency of stamps, and is a repetition of the old "*alcalvala*" tax of Spain, even to the extent of retaining its name slightly modified from *alca vala* to "*alca bala*"; and which Adam Smith, in his Wealth of Nations, describes as one of the worst forms of taxation that could be inflicted upon a country, and as largely responsible for the decay of Spanish manufactures and agriculture. Thus a Federal statute of Mexico, enacted in 1885, imposed a tax of "one half of one per cent upon the value in excess of twenty dollars of transactions of buying or selling of every kind of merchandise, whether at wholesale or retail, in whatever place throughout the whole republic." Also, one half of one per cent "on all sales and resales of country or city property; upon all exchanges of movable or immovable property; on mortgages, transfers, or gifts, collateral or bequeathed inheritances; on bonds, rents of farms, when the rent exceeds two thousand dollars annually; and on all contracts with the Federal, State, or municipal governments." Every inhabitant of the republic who sells goods to the value of over twenty dollars must give to the buyer "an invoice, note, or other document accrediting the purchase," and affix to the same, and cancel, a stamp corresponding to the value of the sale. Sales at retail are exempt from this tax; and retail sales are defined to be "sales made with a single buyer, whose value does not exceed twenty dollars. The reunion, in a single invoice, of various parcels, one of which does not amount to twenty dollars, but which in the aggregate exceed that quantity," remains subject to the tax. Retail sales in the public markets, or by ambulatory sellers, or licensed establishments whose capital does not exceed three hundred dollars, are also exempt.

Tickets of all descriptions—railroad, theater, etc.—must have a stamp, as must each page of the reports of meetings, each leaf of a merchant's ledger, day or cash book, and every cigar sold singly, which must be delivered to the buyer in a stamped wrapper. Sales of imported spirits pay eight per cent on the duties levied on their importation, and a half of one per cent in addition when retailed. Domestic spirits pay three per cent when sold by producers or dealers at wholesale, and a half of one per cent additional when sold at retail. Gross receipts of city railroads pay four per cent; public amusements, two per cent upon the amount paid for entrance; playing cards, fifty per cent—paid in stamps—on the retail price; and manufactured tobacco a variety of taxes, proportioned to quality and value. Mercantile drafts are taxed at a dollar on every hundred.

Farms, *haciendas*, and town estates are required to be taxed at the rate of three dollars per each thousand dollars of the valuation, but such is the influence of the landowners that the valuation is almost nominal. In Vera Cruz the rate is reported at about two mills on the dollar for the most productive portions of country estates; while in the Pacific State of Colima the rate is said to be one and a half per cent. Land and buildings not actually producing income are exempt from taxation, notwithstanding they may be continually enhancing in value. This system of exempting unoccupied realty from taxation also prevails in Portugal; and the Mexican usage was probably derived from that country, where the theory in justification of the practice is, that the use of a thing defines its measure of value, and that to tax unused property is confiscation.

A recent Mexican statute for the taxation of land contains forty-seven different sections, each providing the ways and means of enforcing the tax and prescribing penalties for its infraction. In the towns and cities of Mexico this system of infinitesimal taxation is indefinitely repeated, the towns acting as collectors of revenue for the Federal and State governments, as well as for their own municipal requirements. All industries pay a monthly fee: As tanneries, fifty cents; soap factories, one dollar. So also all shops for the sale of goods pay according to their class, from a few dollars down to a few cents per month. Each beef animal, on leaving a town, pays fifty cents; each fat pig, twenty-five cents; each sheep, twelve cents; each load of corn, fruit, vegetables, or charcoal, six cents (as a supposed road tax), and so on; and, on entering another town, all these exactions are repeated. A miller, in Mexico, it is said, is obliged to pay thirty-two separate taxes on his wheat before he can get it from the field and offer it, in the form of flour, on the market for consumption. As a matter of necessity, furthermore, every center of popu-

lation—small and big, city, town, or hamlet—swarms with petty officials, who are paid to see that not an item of agricultural produce, of manufactured goods, or an operation of trade or commerce or even a social event, like a *fandango*, a christening, a marriage, or a funeral, escapes the payment of tribute.

In fact, trade has been so hampered by this system of taxation that one can readily understand and accept the assertion that has been made, that people with capital in Mexico really dread to enter into business, and prefer to hoard their wealth, or restrict their investments to land (which, as before pointed out, is practically exempt from taxation), rather than subject themselves to the never-ending inquisitions and annoyances which are attendant upon almost every active employment of persons and capital, even were all other conditions favorable. Mexico, from the influence of this system of taxation alone, must, therefore, remain poor and undeveloped; and no argument to the contrary can in any degree weaken this assertion. Doubtless there are many intelligent people in Mexico who recognize the gravity of the situation, and are most anxious that something should be done in the way of reform. But what can be done? If autocratic powers were to be given to a trained financier, thoroughly versed in all the principles of taxation and of economic sciences, and conversant with the results of actual experience, the problem of making things speedily and radically better in this department of the Mexican state is so difficult that he might well shrink from grappling with it.

In the first place, the great mass of the Mexican people have little or no visible tangible property which is capable of direct assessment.

Again, in any permanent system of taxation, taxes in every country or community, in common with all the elements of the cost of production and subsistence—wages, profits, interest, depreciation, and materials—must be substantially drawn from each year's product. Now, the annual product of Mexico is comparatively very small. Thus, for example, the annual product of one of the least developed States of the Federal Union—South Carolina—was in 1888 absolutely two and a half times—or, proportionally to area, twenty-five times—as valuable as the then annual product of the entire northern half of Mexico; and the Argentine Republic of South America, with only one third the population of Mexico, has a revenue twenty per cent greater, and double the amount of foreign commerce. Product being small, consumption must of necessity be also small. "The average cost of living (food and drink) to a laboring man in the city of Mexico is about twenty-five cents per day; in the country, from twelve and a half to eighteen cents. The average annual cost of a man's

dress is probably not over five dollars; that of a woman, double that sum, with an undetermined margin for gewgaws and cheap jewelry." Mr. Lambert, United States consul at San Blas, reported under date of May, 1884: "The average laborer and mechanic of this country may be fortunate enough, if luck be not too uncharitable toward him, to get a suit of tanned goatskin, costing him about six dollars, which will last him as many years." Of household goods, the mass of the Mexican people are almost destitute. A few untanned hides are used for beds, and dressed goat or sheep skins serve for mattress and covering.

The food of the masses consists mainly of agricultural products—corn (*tortillas*), beans (*frijoles*), and fruits—which are for the most part the direct results of the labor of the consumer, and not obtained through any mechanism of purchase or exchange.

Persons conversant with the foreign commerce of Mexico are also of the opinion that not more than five per cent of its population buy at the present time any imported article whatever, and that for all purposes of trade in American or European manufactures, the consuming population is not much in excess of half a million. Revenue in Mexico from any tariff on imports must therefore be limited, and this limitation is rendered much greater than it need be by absurdly high duties, which (as notably is the case of cheap cotton fabrics) enrich the smuggler and a few mill proprietors to the great detriment of the national exchequer.

It is clear, therefore, that the basis available to the Government for obtaining revenue through the taxation of articles of domestic consumption, either in the processes of production or through the machinery of distribution, is of necessity very narrow; and that if the state is to get anything, either directly or indirectly, from this source, there would really seem to be hardly any method open to it other than that of an infinitesimal, inquisitorial system of assessment and obstruction akin to what is already in existence.

But the greatest obstacle in the way of tax reform in Mexico is to be found in the fact that a comparatively few people—not six thousand out of a possible ten million—own all the land and constitute in the main the governing class of the country, and the influence of this class has thus far been sufficiently potent *practically* to exempt land from taxation. So long as this condition of things prevails it is difficult to see how there is ever going to be a middle class (as there is none now worthy of mention) occupying a position intermediate between the rich and a vast ignorant lower class that take no interest in public affairs, and is only kept from turbulence through military restraint. Such a class in every truly civilized and progressive country is numerically the largest, and comprising the great body of producers, consumers,

and taxpayers, is the one most interested in the promotion and maintenance of good government. A tax policy, however, which would compel the landowners to cut up and sell their immense holdings, especially if they are unwilling to develop them, would be the first step toward the creation of such a middle class. But it is not unlikely that Mexico would have to go through one more revolution, worse than any she has yet experienced, before any such result could be accomplished. At present, furthermore, there is no evidence that the mass of the Mexican people, who would be most benefited by any wise scheme for the partition of the great estates and for tax reform, feel any interest whatever in the matter or would vigorously support any leader of the upper class who might desire to take the initiative in promoting such changes; and herein is the greatest discouragement to every one who wishes well for the country.*

THE PYGMY IN THE UNITED STATES.

By JAMES WEIR, Jr., M. D.

IT is highly probable that at one time or another most of the civilized nations of the world knew of certain small, undersized men, and that they constructed and built up legends and myths about them. The ancient Talmudic writers, however, were probably unacquainted with these little people, for nowhere in the Old Testament nor in any of the ancient Hebrew writings are they mentioned. The giant plays a prominent part in more than one biblical drama, but his direct opposite, the pygmy, never appears in any rôle. But long before the Israelitish captivity and exodus, and thousands of years before the five Nasamonians of Herodotus made their memorable journey of exploration into the deserts of Libya, the earliest of known historiographers, the Egyptians, had made his acquaintance, and had made note of his peculiarities of form. Marriette Bey has seen the figure of a pygmy on a monument of the old empire, and

* During the year 1892 the present enlightened President of the Mexican Republic, fully recognizing the great obstruction to trade and commerce which the complicated tax system as above described entails upon the country, created a commission of eminently qualified persons to consider the subject with a view of instituting a better fiscal system. And as one result of its investigations the present Congress of Mexico has adopted an amendment to its Federal Constitution, by which the *alcabalas* shall be definitely abolished in the course of the present year, 1896. Every State in Mexico is accordingly now engaged in modifying its old system of taxation and replacing it with something better. So far as the city of Mexico is concerned, direct taxes have already been substituted for the *alcabalas* on a number of important revenue-producing articles, as, for example, on brandy, alcohol, and pulque.

has deciphered his name, *Akka* (the name by which he is known to this day), written beside him.

The legend of the storks and the pygmies has been familiar to us since our earliest childhood, and I dare say many of us believed in it with a child's unhesitating belief for some years after we had escaped from the thralldom of the nursery. I know that I did, and whenever I would see cranes winging their way southward I would conjure up a mental picture of an army of little men mounted on rams and goats, and engaged in a sanguinary battle with myriads of cranes. I would then lift up my childish voice and shriek out the warning, "Beware of the pygmies!" to the birds flying high above my head. Homer is the first of the classical writers who makes mention of this legend, and he probably borrows from beliefs much older than his time. Says he in the Iliad, Book III, when speaking of the advancing Trojans, whom he likens to a cloud of birds:

> Thus by their leader's care, each martial band
> Moves into ranks, and stretches o'er the land;
> With shouts the Trojans, rushing from afar,
> Proclaim their motions, and provoke the war;
> So when inclement winters vex the plain
> With piercing frosts, or thick descending rain,
> To warmer seas the cranes embodied fly,
> With noise and order, through the midway sky:
> To pygmy nations wounds and death they bring,
> And all the war descends upon the wing.
>
> POPE.

Although Homer does not mention the country of the pygmies in this passage, he does say that the cranes "fly over the ocean" (Pope takes advantage of a poet's license and does not give a literal translation); hence he must have located them unquestionably in Africa.

Aristotle, in his History of Animals, mentions these little men in his description of storks. After stating that these birds pass from Scythia to the marshes of Egypt, "toward the sources of the Nile," he declares that "this is the district that the pygmies inhabit, whose existence is not a fable." A hundred years before Aristotle, however, Herodotus had written of these homuncules, for he says that certain Nasamonians, five in number, had conceived the idea of exploring the deserts of Libya. After they had been traveling in the desert for several days they saw trees in the distance. They made toward these welcome objects, and when they had reached them, and while they were eating the fruit which grew on them in great abundance, they were suddenly surrounded and seized "by a large company of very small men who were much below the average height, and who dragged them

away with them. They did not understand the language of the Nasamonians, nor did the latter understand that of their captors. They were conducted by these little men across a marshy country, into a town whose inhabitants were black. A large stream flowed before this town from west to east, and there were crocodiles in it."

Authorities now unhesitatingly state that this river could have been no other than the Djoliba, or Niger as it is called by cartographers and geographers. This river rises in a cañon of

TASMANIAN. From The Pygmies, Quatrefages.

the mountainous plateau of eastern Senegambia, where it is known as the Djoliba or Joliba, flows northeast, then west, and then southeast, to empty into the Gulf of Guinea near Cape Formosa.

In the neighborhood of Timbuktu, 18° 5′ 10″ north latitude, and 40° 5′ 10″ west longitude; the river flows from west to east. Says De Quatrefages, in Pygmies: "There" (Timbuktu) "the river bends abruptly, and flows almost directly from west to east as far as Bourroum, over a distance of over three degrees of longitude, before turning toward the south to reach the Gulf of Guinea. It is, then, between the first and the fourth degree of

west longitude that the Nasamonea reached the Niger." (It should be noted here that a large proportion of our former slave population was brought from a section of Africa only a degree or so south and east of Timbuktu.) The above-quoted author very correctly states that the town in which the Nasamonians were held captave could not have been the famous Timbuktu, for Ahmed Baba, the celebrated Arab historian and annalist, declares that the town was not founded until the fifth century of the Hegira, or 1100 A. D. But, taking everything into consideration, I am inclined to believe that it was really in this neighborhood that these adventurous explorers met the pygmies, and that the latter at that time had a town on the banks of the river Niger. The incursions of stronger and more warlike peoples probably drove these little men southward, out of the immediate neighborhood of the present site of Timbuktu.

The older writers, notably Pliny, located the pygmies in more than one country. Pliny not only locates them in Africa, but also in India, and modern research has declared that this historian was correct.

In the Vindhya Mountains, Malwa, India (20° to 25° north latitude, and 75° to 80° east longitude), M. Rousselet has found the *Bandra Loks* ("man monkeys"), true pygmies, less than five feet in height. These people are, unquestionably, *bona fide* negritos ("little negroes"). Saint-Pol Lias also found negritos in the province of Perak, called *Sakaies*. These little negroes were all five feet or under, and presented all the characteristic marks of the African pygmies, with the single exception of the protuberant abdomen. This modification of form is probably due to their surroundings. Not only are the negritos to be found in India, but they are to be observed in the Andaman Islands, Bay of Bengal; in the Malayan Archipelago; in Melonesia and Polynesia; and in Australia. This race has penetrated as far north as Japan, for Dr. Maget has found true negritos among the Japanese. They are also to be found in the archipelago of Loo Choo and in Formosa.

The Andamanese probably approximate more nearly in stature and form the pygmies of the United States than do any other tribe of little people save the *Akka* and *Bushmen* of Africa. The Tasmanians, however, resemble our negritos very much, as far as facial angle and expression are concerned. I have, therefore, introduced the portrait of a Tasmanian for the sake of comparison. In recent times explorers have penetrated Central Africa, and have found the smallest of all little people in the region of the country ruled over by King Munza, sovereign of the Monbuttos (1868–1871). Here Schweinfurth found a small colony of pygmies supported by King Munza; their chief, Adimokoû, told Schwein-

furth that his race dwelt farther south. From information given him by this negrito chieftain, this eminent traveler and scientist came to the conclusion that the country of the pygmies was situated about 30° north latitude and 25° east longitude. (I may state, parenthetically, that the pygmies of Africa are called *negrillos* by some anthropologists; why, I know not, for it is generally conceded that the eastern and western pygmies are generically of the same stock. If this be denied, the doctrine of polygenesis must be accepted as true. But while a firm believer in polygenesis, I yet believe that these widely separated tribes of negritos originally sprang from the same root-stock. Their dissemination over such a wide area has been due to one of two causes: either, in times long past, some of them have been carried across the Indian Ocean by storms, or at one time Africa extended across the ocean even as far as Australia. The mighty cataclysm that changed the *Sea* of Sahara into the *Desert* of Sahara, by elevating the northern portion of Africa, probably occasioned a corresponding subsidence, and the eastern portion of the continent, save Australia, the Andaman Islands, and the Malayan Archipelago, was covered by the ocean.)

AKKA. From The Pygmies, Quatrefages.

Chaillé-Long says, in Three Prophets, when returning from the country of King Munza: "I brought back with me, besides the six hundred Niam-Niam warriors, who had joined me in the battles against inimical tribes, . . . a specimen adult woman of the Ticki-Ticki, or Akka pygmy race. Ticki-Ticki is now in Cairo, and is a favorite plaything—being quite an acrobat—in the harem of the Khedive's mother." That adventurous Frenchman and most entertaining writer, Paul du Chaillu, met with pygmies at Niembonai, latitude 1° 58′ 54″ south, and longitude 11° 56′ 38″ east. Here they were known as *Obongos*. He says, in Equatorial Africa, that during his stay in the village of Niembonai he succeeded in measuring six adults, all women save one—a young adult man. The height of the women ranged from four feet four and a half inches to five feet, while the height of the young man was four feet six inches. Finally, Stanley came across these little people at Avatiko, a village near the river Lenda. Two of the pygmies, a man and a woman, were captured by his men and car-

ried into camp. The height of the man was four feet; his hands and feet were small and delicate; his body was rounded and well-proportioned, and his abdomen protuberant; the hair on his body was almost furlike, being nearly half an inch in length. On viewing this little man, Stanley rhapsodizes as follows: "Not one London editor could guess the feeling with which I regarded this manikin from the solitudes of the vast African forest. To me he was more venerable than the Memnonium of Thebes. That little body of his represented the oldest types of primitive man, descended from the outcasts of the earliest ages—the Ishmaelites of the primitive race—forever shunning the haunts of workers, deprived of the joy and delight of the home hearth, eternally exiled by their vice to live the life of human beasts in morass and fen and jungle wild. Think of it! Twenty-six centuries ago his ancestors captured the five young Nasamonian explorers, and made merry with them, at their village on the Niger" (In Darkest Africa). Stanley saw pygmies on several occasions after this, and Emin Pasha gives some interesting measurements in Stanley's book; so, I think, from the evidence adduced, that we can safely assert that there are tribes of pygmies, both continental and insular, in Asia, and that they are likewise still extant in Africa. All of these little negroes, both in Asia and in Africa, have certain anatomical, physiological, and skeletal characteristics in common, which declare that originally they must have come from the same stock. The true negro is dolichocephalic (long-headed); is of an average height as compared with the white race; his form is not rounded, but, on the contrary, is generally spare and angular; he is not at all hairy, and a strong, acrid, hircic, and disgusting odor emanates from his person. The negrito or pygmy, wherever found, is, on the contrary, brachycephalic (round-headed) or subbrachycephalic; he is far below the average height; his form is rounded; his body is generally covered with a soft, downy fell, and no appreciable odor is given off from his person. The true negro has large feet and hands, while in the negrito these members are small and delicately shaped.

While looking over some old papers published in New Orleans in 1842, I found a short description of a batch of, presumably, freshly imported slaves. Among them were "six or eight very small negroes, men and women, all of whom were under five feet in height. Who ran in this cargo is not known, but Mr. —— has the disposal of them." An old bill of sale, now in the possession of Mr. Wolfgang Werner, of Savannah, dated April 23, 1810, gives a description of two adult slaves, male and female, in which the height of the male is declared to be "four feet six inches (4 ft. 6 in.), and the female four feet three inches (4 ft. 3 in.)." Finally, in the possession of the Armistede family, of

Virginia, there is a letter dated "The Oaks," February 20, 1773, and written by Miss Judith Graeme to her friend Miss Sarah Armistede. In this letter Miss Graeme bewails the fact that "Pa has bought four of those trifling, good-for-nothing little 'ginny niggers,' who will steal the cloathes off your back if you give them half a chaunce." After giving a page or so of local gossip, Miss Judith closes her letter with a postscript anent the little negroes, who seemed to have aroused her bitterest animosity. Says she, "The biggest one of those nasty little 'ginny niggers' is not five feet high." Thus we see that over a hundred years ago negritos were brought to America and sold as slaves. For all I know to the contrary, these little negroes had been coming into the country ever since slavery was first instituted. This is probably the reason that pygmies are no longer found in the region of the Niger or in Ashantee. The incursions of the Arab slave dealers have driven them farther and farther inland, until they now inhabit the dense forest solitudes of equatorial Africa. I do not believe that any of the Akka have ever been brought to America and sold as slaves, for the evidence shows that they have occupied the same region of country (Central Africa) for hundreds of years, but negritos closely akin to them and springing from the same root-stock were undoubtedly brought from the west and east coasts of Africa and sold as slaves in America. The descendants of these negritos are our American pygmies, who can be found in large numbers either living in colonies like that in the neighborhood of Charleston, S. C., or Bayou Goula, La., or scattered along the South Atlantic and Gulf seaboards. Hon. W. T. Ellis, member of Congress, who has made a study of these little negroes, says that they speak a language intelligible to themselves alone; that they have undoubtedly retained a large num-

A PYGMY OF THE UNITED STATES.

ber of the words of their ancestral vocabulary; and that they have retained and make use of their original idioms. Of course, many English words have crept in, but these are so commingled with their native speech that their meaning is utterly lost unless one is familiar with the peculiar *patois* that these diminutive individuals make use of. Captain Ellis, of course, has reference to one particular colony, that near Charleston, S. C. In Louisiana these negritos use words borrowed from the French, but so corrupted that it would be difficult for the most expert philologist to trace out their derivation and meaning.

AMERICAN NEGRITO. Bayou la Têche, La.

Crossing has done much toward obliterating the pure type, many of these little people having only their undersized bodies and brachycephalic heads to indicate their origin; and, whenever there is a strain of negrito blood in an individual, he is very apt to possess one or both of these striking characteristics. I have examined a number of these half-breeds and have invariably found them round-headed and of short stature. In some localities, however, the pure type is very prevalent, and one may see the full-blooded negrito who possesses all the distinguishing features of his African or Asiatic brother. Such is the individual whom I have chosen to illustrate this paper. He was born in Bayou la Têche, La., of negrito parents, if his description of them is correct, and came to Kentucky with his "ole mistiss" when about fifty years old. He is four feet nine inches tall, and is perfectly proportioned. A glance at his photograph will show that his feet, notwithstanding the fact that they are covered by rough and unsightly brogans, are small and well made. His hands, although somewhat knotted by rheumatism and hard work, still show traces of their former slimness and delicate outline. His skin presents the characteristic texture of the full-blooded negrito, feeling like velvet to the touch, and is covered by a soft and downy fell. I have known him intimately for years, and have never detected the slightest odor emanating from his person. Finally, he is decidedly brachycephalic, and slightly

hypsistenocephalic. (The vertical diameter is compared with the transverse diameter; when the former is equal to or exceeds the latter, the skull is hypsistenocephalic.) Notwithstanding his age (according to his count he is nearly seventy years old) he is quite strong and active. Mr. A. E. Davenport says that these negritos of the Southern States, notwithstanding their diminutive stature, are very strong and exceedingly active. De Quatrefages says the same of the Andamanese. I have examined a large number of these American pygmies, and have been very much surprised at their strength and agility.

In a number of localities, notably in Florida and Louisiana, the negrito has abandoned civilization and relapsed into savagery. He supports himself by hunting and fishing, and never leaves his haunts in morass and forest, unless compelled so to do by lack of ammunition or other necessary supplies. He is a devil worshiper, paying more attention toward propitiating the Evil One, in order to "keep out of his clutches," than to God, who does not need propitiation because he is good and merciful. Voudou and Walla-walla dances and incantation ceremonies are of almost nightly occurrence among these people. Every hollow tree, every tangled brake, and every miry morass is the dwelling place of either a ghost or an evil spirit. The fetich is greatly in evidence, every hunter carrying about with him some peculiarly formed root or stone, or perhaps a "conjure bag," which he wears securely tied about his neck, and which has been furnished him by some noted "conjure doctor." So much afraid of ghosts and spirits are these negritos that they will rarely leave their hovels at night. Whenever they do go out at night they never go alone, but always in companies. Courtship and marriage among these half-savage negritos possess some peculiarities which have partially originated with themselves; yet some of their customs in these social rites seem to be only modifications of similar ceremonies handed down to them by their ancestors. For instance, the young negrito man will leave a basket of fruit at the door of his sweetheart's hut some time during the night; if she takes it in the next day, he knows that his suit has met with favor. The *Sakies* of India and *Obongos* of Africa go through the same performance. Marriage, however, especially among the Florida negritos, is simply a mating of the two individuals. Where these little people still live in the neighborhood of towns and thickly settled portions of the country, they generally seek the services of a minister or magistrate, though not always.

The dead present awful and awe-inspiring attributes to the pygmies; the ghost of the departed is his *bête noire*; hence, when one of these individuals departs this life, his body is treated

with the greatest reverence. If he happens to be a negrito of the Bayou Goula, Bayou St. Martins, or Bayou la Têche neighborhood, or if he be one of those little people who dwell among the morasses and swamps of central Florida, his corpse is wrapped in bark, securely corded about with strips of hide, and hidden away in some secret place in the almost impenetrable forest. His ghost is supposed to linger in the neighborhood of his body; hence no negrito will ever approach the vicinity of his grave for fear of giving offense, and thereby incurring the enmity of the dead man, which would entail untold and unmentionable horrors.

These little men make splendid hunters, for they seem to have regained (if they have ever lost, which I greatly doubt) that acuteness of sight, smell, and hearing which makes their prototypes in India the very best of *shikaris*. There is no animal in all the woods their equal in cunning; there is no fish in any landlocked bayou or swiftly running stream which can avoid their rude but cunningly set nets and traps.

With their return to savagery these pygmies of the United States seem to have lost all desire for the comforts and refinements of civilization. Their huts among the moss-covered trees lining the bayous of Louisiana, or their still more miserable hutches in the Everglades of Florida, remind one very much of the pictured burrows of the *Akka*, their kinsmen, who dwell in the vast forest solitudes of Central Africa. Like that remnant of the Seminoles also living among the labyrinthine fastnesses of that vast waste of swamp, brake, and forest—the Everglades—these black manikins shun the haunts of men, and when discussing them one quotes almost involuntarily the thoughts of Stanley when he first saw the pygmy of Avatiko. When the wave of immigration turns southward, which it will eventually do, these little people will lose forever their individuality and become merged into the general population. Crossing will finally obliterate the pure type, but we will still continue to find, for an indefinite length of time, among our colored population, individuals with round heads and undersized bodies who will serve to show that once the pygmies dwelt among us.

SOME great advantages are claimed for the metal glucinum which may eventually give it a considerable position in electrical industry. Its resistance to traction is greater than that of iron, and its electrical conductivity is equivalent to that of silver. It should therefore have a greater mechanical resistance than iron, be a better conductor than copper, and, having a specific gravity of only 2, be lighter than aluminum; and these qualities, according to the *Journal des Inventeurs*, have been verified by experiment. Its commercial value is given as equivalent to about one hundred and sixty times less per volume and ten times less by weight than that of platinum.

PENDING PROBLEMS FOR WAGE-EARNERS.

By A. E. OUTERBRIDGE, Jr.

IN studying the important question of management of employees of industrial establishments from a common-sense as well as just and humanitarian point of view, it is necessary to remember that a factory is not an eleemosynary institution; the functions of the two are radically different, and experience has proved that modern manufacturing industries can not be practically conducted under the old idea of paternal or patriarchal regulations. The operative is jealous of his personal freedom and suspicious of purely philanthropic schemes originating within the establishment, and he resents any beneficial regulations savoring of charity. He does not complain of the strict enforcement of just rules, but he is quick to take advantage of laxity on the part of overseers, which, if continued, soon leads to chaos. On the other hand, unjust regulations can not be permanently enforced under the modern labor restrictions, for labor legislation in this country is extremely comprehensive, and takes cognizance of such infractions.* In some instances where labor legislation has been elaborated to a degree which was unduly oppressive to employers, it has served to restrict industrial development, reacting upon the intended beneficiary—the employee—and has necessitated the abandonment of such policy. The "granger legislation" relating to railroads in some of the Western States affords a well-known illustration of this tendency. Employees are no longer ignorant of their rights or privileges, and employers, as a rule, neither care nor dare to trample upon them; but experience has also proved that wherever numbers of men are massed together, a certain degree of strict rule is essential to the preservation of order and proper conduct of business.

Many of the rules and regulations of workshops and factories which appear harsh or unjust to the uninitiated are in reality necessary to protect the faithful employee from impositions of

* The labor laws differ greatly in the different States. Massachusetts has led the way in such legislation, and the other States are following in her footsteps. Most of these laws increase the responsibilities of employers, thus: Methods of protection from fire and accident must be provided in all factories and workshops, and employers can not by contract exempt themselves from liability for injuries to an employee. The buildings must be provided with proper sanitary arrangements; each room where machinery is placed must be connected with the engine room by speaking tubes, electric bells, or appliances to control the motive power.

The most minute regulations relating to the entire economic system of factory construction, operation, and inspection exist; and laws governing the payment of wages, exemption from fines or garnishment of wages or tools of trade for debts, etc., cover every phase of employment growing out of the factory system and are distinctly favorable to labor.

shirkers, of whom there are always a certain number even in the best-regulated establishments.

It is a favorite observation with writers on social and political economy that the world is continually passing through periods of "social evolution"; one of the latest and most popular of these authors (Benjamin Kidd) calls the present time "the most remarkable epoch in the history of human thought." Portents of impending changes in the established order of things, affecting the very foundations of society and the welfare of mankind, are frequently revealed to the innate perceptions of such writers; and it would seem from some of these—more especially the German authors—that the industrial world is now upon the verge of a social cataclysm, out of which a new civilization, the resultant of many opposing forces, would be evolved. Such prophecies (like Benner's) have hitherto apparently obeyed the "law of averages" with respect to the proportion of hits and misses; yet new forecasters of future social conditions, who believe that they perceive shadows of "coming events" cast before, continue to decipher these signs according to their introspective vision rather than through the light of past experience.

The fundamental principle of the Malthusian theory, that population tends to increase in geometrical progression and that the supply of food and other necessaries of life can only be increased in arithmetical progression, tersely expressed the social problem of Malthus's generation; but the subsequent wresting from Nature of virgin soil of vast extent in India, Russia, America, and other parts of the globe, affording feeding ground for countless flocks and herds, together with facilities for plowing, sowing, and reaping unlimited crops through the aid of modern agricultural machinery, and the modern methods of rapid distribution, changed all the former conditions, rendering the law inoperative during the century which has elapsed since its promulgation. Some of the more recent prophecies have proved equally abortive, and others are likely to share the same fate in the near future.

The growth of socialism in Europe during the past quarter of a century is one of the "signs of the times" which is just now affording a fruitful field for such speculations. If we permit ourselves to view the present state of civilization through the spectacles of some of these theorists, or if we countenance the foreign socialistic propaganda, we must, it seems to me, close our eyes to countless evidences of truly wonderful progress which has been made by the wage-earning class in America during this period in mental, moral, and material welfare. The operative of to-day is not only the peer but the superior of his predecessor in all the qualifications that form the mental gauge by which we

may measure the intellectual and social relations that an individual bears to the community in which he lives.

We may freely admit the statement of the socialist that "the rich are growing richer," but it does not follow as a corollary that the poor are growing poorer. It is true that capital through combination has vastly increased its power to organize and prosecute industrial pursuits on a scale of unprecedented magnitude, and that, especially as the result of energetic exploitation of new inventions, large rewards have been gained by bold investors; but I claim that, in the aggregate, labor has gained a much larger share of these benefits without incurring any of the risks.

The rich pecuniary rewards which have been reaped by Sir Henry Bessemer, and by other manufacturers who were far-seeing and courageous enough to develop his cheap process of steel-making and its later modifications, make but a small item when compared to the countless millions paid to labor during the past thirty years as the result of the development of these discoveries through the aid of capital. The Bessemer process of steel-making did more than this for labor: it sounded the death knell of the most exhausting form of toil known to man, that *inferno* of labor, the puddling of boiling iron by human hands. Many similar illustrations could be given.

I claim that modern mechanical inventions have in all cases proved to be distinctively beneficial to the wage-earner: he is, through their aid, better housed, better fed, better clothed, better educated, has more numerous and better amusements, and is thus approaching more nearly to the condition of the employer. Indeed, the wage-earner to-day enjoys many advantages of civilization which were unknown to employers of former generations.

Herr Liebknecht, the leader of the Social Democrats in the Reichstag, presented to American readers The Programme of German Socialism in The Forum. I carefully studied his paper with the view of discovering, if possible, some rational explanation of the problem, "How is socialism going to benefit the condition of the working class in America?" but the question remains unanswered. It is true that figures are given showing the marvelous growth of social democracy in the German Empire since 1890, and the author glories in the title which he gives to German Social-Democracy, viz., "the party of the discontented"; he also perceives signs of "an impending social crisis"; he likens the struggle between socialism and the Government to the fable of the Goblin and the Peasant; but the introduction of such a movement into this country could, I think, be more appropriately likened to the fable of the killing of the goose that laid the golden egg.

The recent presence in this country of more than one agitator from abroad, and the industrious dissemination of socialistic lit-

erature among our workingmen with the evident intention of making proselytes, thereby disturbing the peace of mind of the operative, endangering the stability of our industrial laws, and tending to nullify the gain which has come to wage-earners in America through the comparative freedom from such disturbing elements, is a subject of concern to all friends of the workingmen.

In Germany the literature of socialism has not confined itself to agitation of labor questions, but has catered to the demand for popular reading and also for popular education. In this way it gained the confidence of the people. "It has abused this confidence by giving distorted views of the writings of many of the greatest thinkers and educators"; it has used popular education as a club with which to beat into ignorant skulls socialistic propaganda. The enormous socialistic vote in Germany proves the success of the force used. Such a force, if properly applied, would be immensely beneficial to humanity; but improperly used, socialism is, as Herbert Spencer declares, "the greatest calamity that has ever befallen the human race."

The most intelligible exposition of modern German socialism may be found in a little book entitled Three Months in a Workshop, written by a student, Paul Göhre. In a prefatory note to the English translation, by Prof. Richard T. Ely, it appears that "Mr. Göhre, perplexed by conflicting theories and reports touching the lot of the German wage-earners, determines to become a wage-earner himself, and, donning the garb of a workman, finds employment in a large establishment for the manufacture of machine tools in Saxony; he mingles for three months with his fellows, who never supposed him to be anything else than a wage-earner; he shares their life, participates in their amusements, attends their political meetings, and then tells what he has seen with that simplicity which is itself literary art of a high order. The narrative is plain, straightforward, truthful."

The book is more than this: it is a practical view of a subject which has been clouded in mists. The writer has shown himself a keen observer, a disinterested and enthusiastic investigator, having nerve to enter the factory on the lowest rung of the ladder and to live and toil with the humblest employees, for the definite purpose of grasping the bottom facts of socialism as it is comprehended by the workingmen themselves, not as presented to the world by the leaders in the movement, many of whom do not really belong to the class they assume to represent. That Mr. Göhre should have succeeded, under these heroic conditions, in showing in his little book a clearer insight into the labor question and social democracy in Germany than can be found in many more elaborate treatises, is not altogether surprising. In the

chapters Work in the Factory, and The Material Condition of my Fellow-Workmen, the American student and operative will recognize abuses still existing in Germany which our more progressive establishments have eliminated. The contrast also in rates of wages and quality of living with wage-earners in America will excite sympathy, but will also weld the American more firmly to the belief that the condition of the wage-earner in this country is a happy and fortunate one by comparison; that its stability must not be jeopardized by countenancing socialistic agitation.*

In the chapters on Political Tendencies of my Fellow-Workmen and Social Democracy the student of industrial sociology will find much valuable information. In the chapters on Moral Conditions, and Education and Religion, ethical questions are plainly discussed. The final chapter, on Results and Demands, will interest all readers. It is shown that the labor question is not merely a wage question with the vast majority of the laboring class. It is only one factor in the movement—perhaps the most tangible, but not the most important or determinative one. "There is an ardent longing on the part of the whole class of factory labor for more respect and recognition, for greater actual and social equality in addition to the formal and political equality which is theirs already. . . . It is the irresistible impulse to a larger intellectual freedom, the craving for the benefits of knowledge and education, and for a fuller understanding of those high and lofty problems of the human soul which, despite the universal pursuit of wealth and externals, rise up before humanity today, new riddles in new forms. All this, rough, discordant, full

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* On entering the shops, Mr. Göhre received twenty *pfennige* (4 8 cents) per hour. Compulsory deductions were made for assessments for sick-benefits, insurance, fines for lateness or carelessness, etc.

Men working at the vise earned fifteen to twenty-one marks ($3.60 to $5.04) per week; their foremen, $5.28 to $6.72; drillers working on time, $3.60 to $4.56. "Piece workers" made considerably more. A specially skilled workman "would receive as much as forty marks ($9.60) per week." It thus appears that the highest wage of the most skilled operative slightly exceeds the lowest wage for unskilled labor in this country. The home life of the men was shown to be on a plane far below that of the average wage-earner in America.

Some suggestive and important information is to be gathered from a book just issued by the British Board of Trade, giving the statistics of wages paid for manual labor in Great Britain. From this it seems that the average earned by men is $6.03 a week; by women, $3.08; by boys, $2.24; and by girls, $1.56. These are the averages of the wages of 816,106 persons. In Scotland the rates are lower than in England by ten and in Ireland by some twenty per cent. The best-paid trade is that of builders, and then, in order, distillers, brewers, metal workers, engineers, sawmill workers, coach builders, and printers. Railroad men average five dollars a week. The chances of earning ten dollars a week are not common. Thirty-seven per cent of the printers, thirty-three per cent of the tinplate workers, thirteen per cent of the shipbuilders, eleven per cent of copper and brass workers, and ten per cent of coopers attain that amount. On the whole, the report indicates that wages in all British trades are on the increase, but at a very slow rate of progress.

of anomalies and extravagancies, yet plainly visible to the observant eye, stamps the beginning of the labor movement in Germany."

If confined to such lofty aims, the mission of socialism would be worthy of, and would command the sympathy and hearty cooperation of all enlightened people; but Mr. Göhre shows that it is necessary first to unmask the hypocrisy of social-democratic literature, to oppose the true to the false, the impartial to the partisan; he tells us that "German Social Democracy is to-day not merely a political party, not merely the promoter of a new system of economics, or even both of these and nothing more; it is also the embodiment of a philosophy, a logical, anti-Christian, materialistic conception of the universe. Upon this materialistic system it founds its economic and political system. This principle, the caricature of a so-called science, worshiped by its followers, is the corner stone of the party, gives it authority and ideals, and exercises the most fatal and lasting influence, not so much on the social and political tendencies as on the intellectual and ethical character of the whole German laboring class." This new gospel of socialism ran like wildfire among the hundreds of thousands of German workingmen. Herr Liebknecht tells us that "nearly two millions of men voted for the socialistic programme on the 15th of June, 1893, to whom must be added nearly a million of voteless young men between the ages of twenty and twenty-five years."

The spread of socialism in Germany has now reached the degree which is popularly termed with us a "craze." Its earliest converts became its new prophets, its inspired preachers; from inner conviction they gave their whole strength, their utmost capacity, to the cause. "Wherever two or three met together men set forth and discussed the thoughts they had imbibed from one book or half a dozen books of the new literature; sometimes fairly grasped, sometimes only half comprehended and more than half forgotten, but always brought afresh to their minds by the articles in their social-democratic paper. . . . The effect of this agitation was the one desired. Under its pressure all the old youthful training of the workman gave way and is still giving way in every individual who brings such training with him to a factory where the spirit of social democracy prevails."

If, now, we cull out these true and noble yearnings of the workingmen, discarding the sophistries of their self-elected leaders, we find that their aims are those which have already been largely attained by the wage-earning class in America through education; and while we may reasonably sympathize with the German "party of the discontented," we have nothing to gain by the dissemination of their socialistic literature, though they have much to learn from us.

In England the socialistic movement presents a different phase of development; there are fewer factions or cliques of socialists, and the tendency toward anarchism, while not so rabid as among the most radical wing of the party in Germany, is apparently even more generally diffused. Some of the recent socialistic literature published in England has a decided flavor of anarchism, at least in so far as it preaches the overthrow of laws by which land is held in private ownership; the private or corporate ownership of all kinds of property, factories, railroads, telegraphs, etc.; and evidences are not lacking of widespread discontent and unrest among the industrial population, which devours such literature with avidity. It is reported that a million copies of a single book of this character have recently been sold to workingmen in England.

The latest cabled reports indicate that a reaction in labor sentiment has set in in England. There was recently a "Free Labor Congress" in session at Newcastle. The president's opening address is reported to have been "a vigorous attack on trades unions, which, he declared, were manipulated by self-seekers, whose tyranny disgraced the cause of labor." His association, he said, had already formed "boards of conciliation" at many important centers. These boards were formed of equal numbers of masters and operatives, and were all working in perfect harmony. An editorial writer, commenting upon this cablegram, says: "The revolt from trades unions was not unexpected. It was bound to come as soon as the more intelligent workmen perceived that they could no longer own themselves, but were virtually made slaves of the lazy and inefficient members of the organization. It is singular that this should have been perceived first in England instead of in America." This writer is evidently not well posted in the history of the rise and fall of several labor unions in this country, which a few years ago counted their members by thousands where they now number units. Compared with a period of four or five years ago the majority of the unions have sunk into a condition of "innocuous desuetude," controlled by cranks.

Labor unions, however, should not all be classed under one category, for some of these are beneficial organizations, with high motives, sound constitutions, and, above all, wise leaders. Such organizations are opposed to violence and disorder, encourage harmony and arbitration, and are mutually beneficial and helpful to employer and employee; they are aiding to discourage the spread of anarchism and socialism in this country.

Socialistic theories are inimical to American ideas and principles, for the humblest workman is a free citizen, to whom a pathway is opened to the highest positions of honor and wealth. Many of our foremost men have risen from lowest origin, and

have no cause to be ashamed thereof. Socialism can offer no commensurate advantages; its tendency is not to raise the masses to a higher plane, but to reduce the competent to the level of the incompetent. The world is always crowded with incompetent operatives, while there is at the same time an unsatisfied demand for the absolutely competent.

In daily friendly intercourse with workingmen, extending over a period of twenty years, I have found a prevalent idea in many minds that employers of labor are, as a class, jealous of the material advancement of wage-earners beyond a certain point; that a maximum wage is soon reached beyond which they can not hope to pass, and that extra effort on their part would result merely in an increase of tasks without a corresponding increase of pay. This impression is more generally inculcated in the minds of operatives than employers realize, and it operates to their mutual disadvantage. Modern "piece-work" systems of pay have been devised (and are now generally practiced) with a view of stimulating workmen to produce the greatest output and largest percentage of perfect work; but these elaborate systems are to a certain extent rendered inoperative by reason of the suspicion mentioned. That there may have been, and may still be, some ground for such impressions I do not dispute, but I do believe that a more enlightened view of the mutual relations existing between employer and employee is gradually permeating the industrial world.

The great development of mechanical invention has not only increased the demand for skilled labor by increasing the output and opening constantly new fields of labor, but it has increased tenfold, and in some instances one hundredfold, the possible product of labor *per capita*. This is the reason why the American employer, paying the highest wages in the world, is nevertheless able to compete in the markets of Europe with so-called "pauper labor" in many manufactured articles.*

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* Mr. Mulhall, the English statistician, has recently published some tables relating to the producing power of the different nations of the earth. They show an enormous increase during the latter half of the century of the productive power of the people of this country, and they prove, moreover, that no other nations possess equal producing power *per caput*. By the figures which he has tabulated Mr. Mulhall shows that from 1820 to 1890 the "foot-ton" power of the United States increased from 4,292,000,000 of foot tons daily to 129,306,000,000 foot tons. A foot ton is a method that statisticians have of measuring the producing powers of a country. It signifies the ability of a man to accomplish with ordinary exertion in ten hours an amount of work equal to raising 300 tons one foot high. In 1820 the forces at the command of the Americans were equal to 446 foot tons of power *per caput* of the population. By 1890 the productive forces had increased to 1,940 foot tons *per caput*. These forces are now busily engaged in developing the resources of the country, in cultivating the soil, working the mines, operating the industries, carrying on the commerce, or in looking after the development of the mental powers and the enlightenment

It has been proved by actual experiment on a large scale in certain sections of this country that ignorant foreign pauper labor in manufacturing industries is ultimately the most costly, and the aim of enlightened employers to-day is not to obtain the cheapest labor but the most intelligent service. The true policy of the workingman is, therefore, not agitation but education.*

The organization through the aid of capital of large industrial operations, superseding former small independent industries, is a frequent source of lamentation on the part of well-meaning philanthropists and others, on the theory that the small merchant has been injured thereby. This is probably true in isolated instances, but the evidence that the wage-earner (the subject of our discussion) has been benefited by improved regulations, superior factory buildings, and amelioration of exhausting toil, under modern methods, is overwhelming.

Moreover, the employment of large capital and improved machinery has enormously increased production and decreased cost to the consumer. Wages are higher and cost of living is lower than formerly. The average wage-earner in America lives to-day in a manner quite superior to the small manufacturer of former days. The large factories employ armies of skilled operatives many of whom would be incompetent to conduct even small industries successfully. They are reasonably insured of a fixed income, and are often enabled, by saving a portion of their wages, to become small capitalists themselves. Capital is, after all, nothing more than the aggregate savings of labor. The great financial operations are conducted by the aid of these savings of the masses, otherwise the thrifty workingman could receive no interest on his deposit in the savings bank. The individual millionaire is a much less important factor in the world's work than the socialistic agitator would have us believe.

The "good old times" are hallowed in our recollections and in our traditions, but when subjected to critical comparison with the improved civilization of modern times, we find, I think, that the

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of the people, whereby their producing powers may be still further increased. Next to America in the scale comes Great Britain, the producing power of which is 1,470 foot tons to the inhabitant daily. Germany's forces amount to 902 foot tons for each person daily, those of France to 910 foot tons, those of Spain to 590 foot tons, those of Austria to 560 foot tons, and those of Italy to 380 foot tons.

* Thomas Carlyle, in his essay on Labor, said: "The latest gospel in the world is, Know thy work and do it; . . . for labor is life; from the inmost heart of the worker rises this God-given force. . . . Knowledge, that will hold good in working, cleave thou to that, for Nature herself accredits that, says 'Yea' to that. Properly thou hast no other knowledge but what thou hast got by working; the rest is all a hypothesis of knowledge—a thing to be argued of in schools, a thing floating in the clouds, in endless logic vortices, 'till we try it and fix it.'"

masses have gained immeasurably in all the comforts and conveniences of life, in social position, in political power, in freedom from care, in health and happiness.

The coming conflict between proletariat and plutocrat is a favorite theme with socialistic writers. According to these, wealth is *per se* criminal, and its chief employment the oppression of the poor. I claim that modern experience proves the antithesis of this statement, which selects exceptional instances of financial crimes and attempts to use these as a blanket with which to smother all the good deeds and grand undertakings in which capital is ever engaging. Patriotic sentiment also protests against such statements. The aid of capital has been the means within little more than a century of raising the United States of America from the condition of an insignificant agricultural colony, which was not permitted under monarchical rule to manufacture the simplest articles for home consumption, into the greatest workshop of the world, and has placed it in the front rank of wealth and power among nations.*

Capital has stimulated the inventive faculty of the people and thereby aided the operative in many instances to emerge from the condition of the laborer into that of the capitalist. Very many, perhaps a majority of employers in this country, are men who have risen from the ranks of labor.

The reckless denunciation of wealth by foreign socialistic agitators is the chief danger confronting the industrial class in America to-day, since it tends to retard investment of capital in industrial enterprises, and thus to restrict the employment of labor. It is far easier for the agitator to "kill the goose that lays the golden egg" than it is for the mischief-maker to turn his hand to honest labor. The free soil of America is not adapted to the growth of such noxious weeds, and the sooner such pernicious doctrines are eradicated the sooner will our industrial population reap the rewards to be gained in the returning prosperity for which it has so long and patiently waited.

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* The first spinning jenny ever seen in America was secretly imported from England and exhibited in Philadelphia in 1775. In 1774 the British Parliament enacted stringent laws prohibiting the exportation to America of textile machinery. It was provided (by 21 George III, chap. 37) that "any person who packed or put on board, or caused to be brought to any place in order to be put on any vessel for exportation, any machine, engine, tool, press, paper, utensil, or silk manufacture of the kingdom, or goods wherein wool, cotton, linen, or silk are used, or any model or plan of such machinery, tool, engine, press, utensil, or implement, should forfeit every such machine, etc., and all goods packed therewith, and £200, and suffer imprisonment for one year." In 1782 a law was enacted which prohibited, under penalty of £500, the exportation or attempt to export "blocks, plates, engines, tools, or utensils used in, or which are proper for, the preparing or finishing of calico, muslin, etc." The same act prohibited transportation of tools employed in iron and steel manufactures.—*United States Tenth Census, vol. ii, p. 537.*

APPENDIX.

THE COST AND DANGER OF STRIKES.—Few persons are aware of the enormous annual loss of wages due to strikes. Startling figures are furnished by the Labor Bureau at Washington in a recent publication covering the period from 1881 to 1894 inclusive,

It appears that no less than 3,714,406 persons were thrown out of employment, suffering a loss in wages of $163,807,866. Fifty-five and a half per cent of the strikes failed entirely; thirty-two per cent are classed as successful, and twelve and a half per cent as doubtful or partly successful. Labor organizations contributed $10,914,406 to assist strikers.

The promoters of strikes argue to their comrades that unsuccessful efforts are nevertheless ultimately beneficial; but study of the subject has led me to take the opposite view, viz., that all strikes of skilled workmen are, in the end, harmful to the participants. No one single cause has done more, in my opinion, to hasten the introduction of entirely automatic machinery in operations where a certain degree of skilled labor was considered indispensable, than strikes on the part of such skilled employees. Numerous instances might be recalled where large manufacturers have, on account of strikes, cheerfully expended immense sums of money in perfecting automatic machinery, not primarily to effect economy in wages, but as an insurance against future danger from such causes.

A notable instance of this nature occurred a few years ago at one of the largest iron and steel works in the world. In a certain department specially skilled men were able to make wages which now seem incredible; they were, however, paid a percentage upon the tonnage, and, owing to enormous output, the profits of these operatives exceeded in some years that of many successful manufacturers having large capital at stake. These men considered themselves indispensable, and struck, not for higher wages or shorter hours but at the dictation of outsiders. When work was resumed they found their occupation gone forever: automatic machinery had supplanted the former skilled labor.

I do not believe that any employee (I am one myself) is indispensable, and many highly skilled and otherwise valuable operatives have, unfortunately for themselves, failed to appreciate this fact until too late.

The danger I have indicated regarding the effect upon skilled labor of strikes does not appear to have presented itself to the minds of the workingmen, and if their leaders have perceived it they have concealed it. I regard the strike as a barbaric weapon of attack, resembling somewhat the boomerang, which, we are told, frequently returns and injures its projector.

Another element of danger to the workingman which usually accompanies a strike is the license which it affords to the irresponsible and lawless element of society to commit depredations, endangering the lives and property of innocent persons, and sometimes compelling the use of armed force for its suppression. The strikers, though innocent of these overt acts, are injured thereby, and the suspicion lurking in many minds is not without foundation, that some leaders of strikes, while openly exhorting their followers to preserve the peace, secretly count upon this outside aid; and if they do not, they are strangely blind to the result of past experience.

THE EIGHT-HOUR AGITATION.—This is the fundamental principle or philosophy of the trade-union movement in this country, and in 1888 "the American Federation of Labor," numerically one of the strongest of the unions, voted to unite with the "Eight-hour League," and thenceforth to concentrate all effort on the struggle for eight hours. Their programme was then to take charge of one trade at a time. Thus, in 1890, the gage of battle fell to the lot of the carpenters, who accordingly struck, under orders, for an eight-hour day on May 1st, and won temporary victories in one hundred and thirty-seven cities. Plans were laid for the miners to strike, on May 1, 1891, for eight hours, but the conditions were not then favorable, and although these plans have since been in abeyance owing to depressed conditions of trade, they have not been abandoned, and I have reason to believe that employers in almost all trades will be called upon to meet this question in the not very distant future.

The argument of the eight-hour philosophers is that, by restricting the hours of work, more laborers must be employed and the idle surplus provided for; I consider that this is specious reasoning. The overflowing stream of immigration from European countries, attracted to America by comparatively high wages, suffices even now to produce a permanent flood, at least in the fields of unskilled labor. If to this we add a still more powerful attraction of eight hours forming a legal working day, the tidal wave flowing from all the less favored countries in the world would swamp our native industrial population and induce a condition which would be far less favorable to them than that which now obtains.*

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* I am able to substantiate these views by figures bearing upon the subject. The official statistician of Paris, M. Berthelot, gives the proportion of foreigners in that city as 7·5 per cent; these are chiefly wealthy persons who distribute a portion of their funds among the tradespeople. London and Vienna have each 2·2 per cent. Berlin has 1·1 per cent of foreigners, also mainly persons of wealth.

The foreigners residing in American cities are chiefly poor immigrants who compete with the native working class for wages, and are accustomed and content to live in comparative squalor. The percentages of "foreign born" to total population in five principal American cities are as follows: Philadelphia, 25·74 per cent; Boston, 35·27 per cent; New York, 42·23 per cent; Chicago, 40·98 per cent; Milwaukee, 38·92 per cent. *More than thirty per cent of the foreign-born males, twenty-one years of age and over, in the five cities named, are aliens.* The percentages of "persons of foreign parentage" to total population in these cities are as follows: Philadelphia, 56·58 per cent; Boston, 67·96 per cent; Chicago, 77·90 per cent; New York, 80·46 per cent; Milwaukee, 86·36 per cent. This information was courteously furnished by the Chief of Census Division, Department of the Interior, Washington, March 12, 1896.

More rigid enforcement of contract-labor laws has decreased importation of foreign labor under direct or written contract, but there is ample evidence that Italian labor purveyors still influence such immigration. Immigrant inspectors Birmingham and Hinkle reported (under date of January 11, 1895) to the Secretary of the Immigration Investigation Committee, among other facts, as follows: "Mr. Desabadia (an Italian padrone of New York) informed us that he was regularly engaged in supplying Italian laborers in any numbers to contractors or others desiring labor done; that he was prepared now to furnish from two to six hundred men (Italians) for work of any nature; that he could furnish stonemasons, carpenters, or men of almost any of the building operations."

The equivalent of the padrone system is not confined to Italians. Poles, Hungarians, Greeks, and other foreigners, temporarily camping in this country, are forwarded "on call"

The eight-hour party has succeeded through political influence in making eight hours a legal working day in governmental employment, and largely also in municipal contracts, and violators of the law have been rigorously prosecuted. A remarkable case occurred in Buffalo,* which worked great hardship upon a citizen, and led to the decision of Justice White, of the Superior Court at Buffalo, declaring the eight-hour law unconstitutional, based upon the clause of the Constitution which provides that no person "shall be deprived of life, liberty, or property without due process of the law." That provision of the Constitution has been construed to mean that the rights and privileges of a citizen to make contracts relat-

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wherever large operations are in progress, crowding out American labor by accepting lower wages. In Texas and other border States invasions of Mexicans occur at regular intervals, especially at sheep-shearing time; these people contribute nothing to the wealth of the country, and patronize the railways by walking home on the ties!

An investigation made by the Senate Committee on Immigration in 1893 (Senator Hill chairman) developed the startling fact that Italian bankers remitted to Italy from New York city alone twenty-five to thirty millions of dollars a year, largely savings of "Dago" laborers, and a marked increase in wealth in certain sections of Italy has been traced directly to money earned in the United States by these "birds of passage." Italians who have become domiciled here for a few years are beginning to make incursions into skilled labor fields where they were unknown formerly, and where even such a suggestion would have been ridiculed. In the shoe trade, for example, it is said that large numbers of Italians have been substituted for American workmen who went out on strike some time ago.

The facts stated in these various footnotes have been gathered at different times during several years by the writer from a variety of independent sources, and it is only when placed in juxtaposition that their true significance becomes apparent. These illustrations are but a few samples of facts at hand that are too numerous to mention, and they present practical problems for legislators and workers of far more importance than any theoretical discussions.

* "Henry J. Warren, Superintendent of the Barber Asphalt Company, was convicted by a police court in Buffalo of a misdemeanor for a violation of this (eight-hour) section of the Buffalo charter, and punished by imprisonment. From his conviction he appealed to the Court of Sessions and to the General Term of the Supreme Court, where the conviction was affirmed, the courts holding the act constitutional and the conviction valid. As Warren could not by law appeal to the Court of Appeals in that case, he sued out a writ of *habeas corpus* in the Supreme Court, to test the questions affecting the validity of the conviction, and to inquire by what authority he was restrained of his liberty. This proceeding is a good illustration of the efficacy of the ancient writ of *habeas corpus*, for, although the Special and General Terms of the Supreme Court dismissed the writ, and again declared the prohibitory statute constitutional and the accused properly convicted; yet upon an appeal to the Court of Appeals the decisions of the lower courts were reversed, and the arrest, trial, and conviction declared without jurisdiction and void.

"After this long and tedious fight Warren was released, only to be arrested again for a violation of the eight-hour law, this time for employing an alien Italian laborer. He was indicted by the grand jury, and convicted in the Superior Court at Buffalo. His counsel contended that the act in question, so far as it seemed to prohibit the employment of alien laborers upon public works, was repugnant to the Federal and State Constitutions and to the treaty between the United States and Italy. Upon an appeal to the General Term of the Superior Court, the act, so far as relates to the employment of aliens, was declared unconstitutional, and Warren was discharged." (People *vs.* Warren, 77 Hun., 120; People *ex rel.* Warren *vs.* Sheriff, 144 N. Y., 225.)

ing to his business or property can not be interfered with by legislation. It has been declared by the courts that liberty, in its broad sense, as understood in this country, means the right not only of freedom from actual imprisonment, but the right of one to use his faculties in all lawful ways, to live and work where he will, to earn his livelihood in any lawful calling, and to pursue any lawful trade or vocation. All laws, therefore, which impair or trammel these rights, which limit one in his choice of a trade or profession, or confine him to work or live in a specified locality, or exclude him from his own house, or restrain his otherwise lawful movements, except where the public health or safety intervenes, are infringements upon his fundamental rights of liberty, which are under constitutional protection. (People *vs.* Warren, 34 N. Y. Supp. Superior Court, Buffalo, 942.)

The impossibility of regulating the rate and hours of labor by legislation unless in the exercise of the police power, or law of public health and safety, was recognized years ago by Chief-Justice Ruger, in McCarthy *vs.* Mayor, who said in reference to the original eight-hour law then under discussion:

"It is well to premise that this act was not intended to affect or regulate the rate of wages which should govern as between employer and employee. That subject is left by the act, as it always must remain, open, to be fixed by the agreement of the parties intending to enter into those relations. Experience has shown that legislation on the subject must always be futile and ineffectual, for the reason that it is controlled by the natural laws determining the value of labor and property, and which are as much beyond the power of statutes to affect as they are above the control of the wishes of the parties interested therein."

I do not mean to imply from the foregoing statements that I am opposed to shorter hours for labor; on the contrary, I believe that a shorter working day, wherever it is practicable, is beneficial alike to employee and employer; but under present conditions, it appears to me, after a careful survey of the field, that there are some prominent obstructions which must be removed before an eight-hour day can be universally adopted, or before the operatives who now work ten hours a day can reasonably hope for a general reduction to eight hours without a corresponding reduction of wages.

Wise men usually count the cost of any new undertaking before embarking in it, and a very simple calculation will show surprising figures as to the additional cost of manufacture should employers be called upon to pay the same wage for eight hours' that they now pay for ten hours' work. Let us assume that an establishment employs a thousand hands (there are factories having capacity for four or five times this number), a reduction of two hours per day per man would mean an aggregate of two thousand hours' reduction per day in the shop. Assuming the average wage to be ten cents an hour (this is much below the true average), the additional cost for this item alone would be two hundred dollars per day; while the loss from decreased output and increased fixed charges, rate of interest on plant, etc., per unit of product, would, I believe, extinguish any margin of profit obtained under present prices in any manufactured article where competition is keen. It is of course possible that in those occupations in which the output depends more upon manual dexterity than upon the mere tending of automatic machinery a decrease of hours may be partly offset by an increase of effort; but this would, I think, prove an exception, the effect of

which is discounted, in part at least, by the low figure selected to represent average wages.

It is apparent that a rearrangement of some kind would be necessary; is it not likely that this rearrangement would be found in a corresponding reduction of wages?

Sympathizing as I do with all legitimate efforts of workingmen to better their condition, it appears to me that the aim of their organizations should be to secure a reduction in the hours of those workers who are compelled to submit to clearly excessive consecutive hours of attention to duty —conditions that are not only deleterious to the welfare and happiness of the laborer himself, but in some instances increasing the danger to life and limb of others whose interest and sympathy would be a powerful lever, if properly applied, to help to remove this incubus resting at present upon the boasted freedom of labor in this country.

If the views which I have here advanced shall have the effect of tending, on the one hand, to discourage unwise and impracticable schemes of some misguided wage-workers, and, on the other hand, to stimulate keener and more general interest on the part of employers of labor in the welfare of their operatives, and thus to foster a closer union between these two great interdependent elements of society, I shall feel that my efforts have been repaid. The nature of my occupation for the past fifteen years has perhaps afforded unusually favorable opportunities for viewing both sides of the sociological questions here discussed; it has certainly aroused keen personal interest in the subject and has stimulated study of these problems.

THE PHYSIOLOGY OF COLOR IN PLANTS.

By D. T. MACDOUGAL,
ASSISTANT PROFESSOR OF BOTANY IN THE UNIVERSITY OF MINNESOTA.

THAT the color exhibited by the roots, stems, leaves, and especially flowers and fruits of plants received serious attention at a very early date is well attested by ancient record. It was only in comparatively recent time, however, that the daring conjecture was hazarded that even such an abundant, widely distributed, and characteristic color as chlorophyll (leaf-green) subserved a purpose in the life-process of plants. Doubtless certain masses of marked color, or combination of pronounced tints, must have afforded a gratification to man's sense of beauty quite, early in his development. At the same time and earlier these colors were also used as a distinguishing mark in the selection of plants for food, and later they were taken to be indicative of the absence or presence of magical curative properties. The first-named feature is still valid, and forms the basis of the art of the gardener and florist to-day. The last-named aspect of plant colors received its greatest attention during the prevalence of the practices of the Grecian Rhizotomoi and Pharmakopoli, and later in the "doctrine of signatures." The doctrine of

signatures supposed that the color and form of plants indicated their relations, good or evil, to the human race, in reference to which they were especially created. This crude superstition attained greatest favor in the sixteenth century, and is still prevalent in obscure form among the lower classes in certain portions of Europe. The use of colors as a distinguishing mark between species, families, and groups began quite early in the history of attempts at classification, and still forms a minor character in modern systems. A wholly new point of view was that taken by Konrad Sprengel, in his history of the biological significance of color (Das entdeckte Geheimniss der Natur im Bau und Befruchtung der Blumen; Berlin, 1793). To Sprengel is due the idea that the colors of the secondary reproductive organs are a device for the attraction of insects, thus securing cross-fertilization. Investigations in many directions from this idea have revealed the fact that plants in a similar manner attract insects and other animals for many other purposes besides fertilization, and in some instances avoid such visitors, for various reasons connected with their development, in a similar manner. Such an amount of attention has been given to these ecologic color adaptations that the aggregate mass of the results recorded is nothing short of colossal. That these results are of immense value and importance goes without saying: yet, given such a thesis, it is impossible that the observations of both trained and amateur workers should not contain a large number of misinterpreted facts. The general principle has been drawn upon to furnish solutions to complicated or unusual arrangements of color, in a manner highly improbable and unscientific and in many instances verging upon the impossible and ridiculous. That it can not be assumed *a priori* that the colors exhibited by the flowers or any other organs of the plant are devices to attract and guide insect visitors is becoming more and more apparent. Timely attention has been called to the perversion of this principle by the writer of a recent article on floral biology (Willis, Science Progress, No. 21, 1895). That great care is necessary in the interpretation of areas of color in plants is emphasized by the fact that accumulating observations tend to show that a color sense is wholly lacking except among the higher insects, and that if the colors of flowers were fashioned to attract insect visitors the directive impulse must have been received at a very recent date—that is, since the acquisition of the color sense by insects. It is by no means the purpose of this article to discredit the great mass of well-confirmed facts concerning the uses of the colors as an adaptation to insect visitors, but chiefly to call attention to conclusions afforded by the last fifteen years of research upon the formation and physiological uses of color in plants. The functions sub-

served by many of the coloring substances besides chlorophyll are by no means secondary in distribution or importance to the individual plant to the exterior adaptations described above.

The principal coloring matters among the higher plants besides chlorophyll (leaf-green) are those which have been grouped under the terms erythrophyll, xanthophyll, and anthocyan. Of these substances the chemical and physical properties of chlorophyll are best known, although its exact composition is yet undetermined. Not only is our chemical knowledge of the non-green colors very vague, but it is thought that a great number of different substances are grouped under each of the above and other color terms. Thus, for instance, anthocyan is made to include the large number of substances to which are due the red, blue, violet,

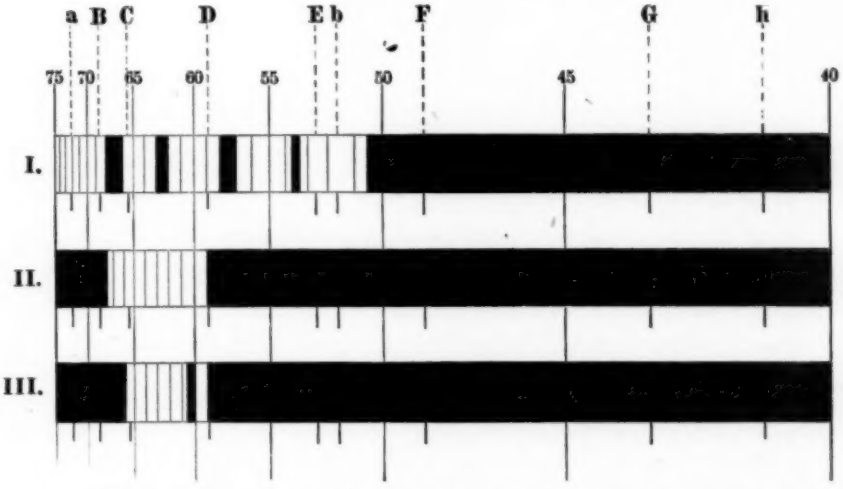

FIG. 1.—I. SPECTRUM OF CHLOROPHYLL SHOWING SEVEN ABSORPTION BANDS. The two in the red-yellow between B and D, and the three in the blue-violet, beyond F, are the most important and characteristic. The bands between D and E are most marked in the spectra of solutions which have been exposed to the air and light some time, and are believed to be due to disintegration products of chlorophyll.

II. SPECTRUM OF AMARANTH-RED. All the rays except those falling between B and D have been absorbed.

III. SPECTRUM OF AUTUMNAL COLOR OF LEAVES OF AMPELOPSIS. All the rays except a part of those falling between C and D have been absorbed.

and purple colors of such plants as the violet, beet, canna, rose and amaranth. Only so much is known of the formation of these color substances as to justify the assertion that many of them are produced as disintegration products of the glucosides and others from a mother substance—chromogen.

The coloring matters of plants may be in solution in the cell sap as in the beet and amaranth, in irregular solid masses in the sap or protoplasm, as in nasturtium (*Tropæolum*); or may be incorporated in the cell wall, as in logwood (*Hæmatoxylon*); or

dissolved in minute oil drops suspended in special masses of protoplasm, as is the case with chlorophyll.

Although this article is particularly concerned with the non-green colors of plants, yet it will be necessary to outline the function and adaptations of chlorophyll, to which these substances

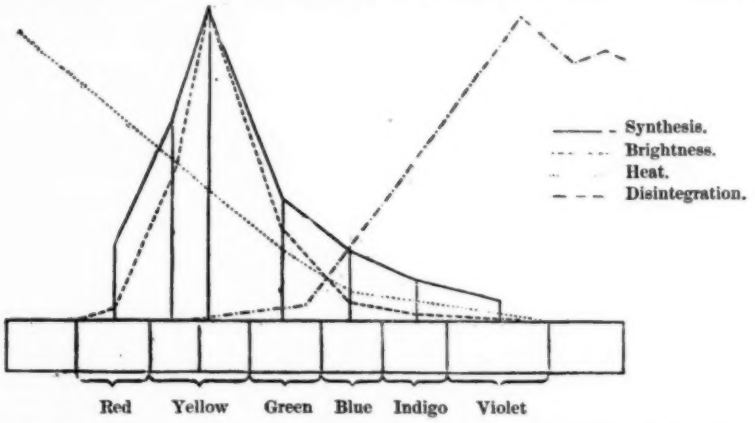

FIG. 2.—CURVES SHOWING BRIGHTNESS AND SYNTHETIC, THERMAL AND DISINTEGRATING EFFECTS OF THE REGIONS OF THE SOLAR SPECTRUM.

bear a special relation. Chlorophyll is perhaps the most important coloring substance in the world, for upon this substance depends the characteristic activity of plants, the synthesis of complex compounds from carbon dioxide and water—a process upon which the existence of all living things is ultimately conditioned. Only in a very few unimportant forms devoid of chlorophyll can the synthesis of complex from simple compounds or from the elements be accomplished. The function of chlorophyll may only be comprehended when its chief physical properties are understood. These may be best illustrated if a solution of the substance is obtained by placing a gramme of chopped leaves of grass or geranium in a few cubic centimetres of strong alcohol for an hour. Such a solution will be of a bright, clear green color, and when the vessel containing it is held in such a manner that the sunlight is reflected from the surface of the liquid it will appear blood-red, due to its property of fluorescence, that of changing the wave length of the rays of light of the violet end of the spectrum in such manner as to make them coincide with those of the red end. It is by examination of light which has passed through a solution of chlorophyll, however, that the greatest insight into its physical properties may be gained. If such a ray of such light is passed through a prism and spread out on a screen, it may be seen that there are several large intervals or dark bands in the spectrum. The rays of light which would have occupied these spaces have been absorbed by the chlorophyll, and

converted into heat and other forms of energy. This energy is directly available to the protoplasm containing the chlorophyll, and by means of it the synthesis of complex substance may be accomplished. Moreover, the amount of synthesis accomplished by plants exposed to separate portions of the spectrum will be directly proportional to the amount of that portion which can be absorbed and converted into useful forms of energy. This is graphically illustrated in Fig. 2. The amount of synthesis is shown to be greatest in the red light between B and C, where the greatest absorption takes place. (See Fig. 1, I.)

Chlorophyll is a very complex and highly unstable substance, and during the absorption of light it is slowly broken down, but ordinarily it is rebuilt by the protoplasm as fast as it is decomposed. If, however, the chlorophyll and the leaf containing it are exposed to a light of such intensity that the chlorophyll is decomposed faster than it can be rebuilt, then damage must ensue, which if sufficiently extensive will result in the death of the entire leaf. The intensity of the light which induces a maximum of activity in any plant, and which it may receive without damage, is determined by its specific constitution. The intensity of light falling on a plant in an open plain during twenty-four hours ranges from almost total darkness to the blaze of the noonday sun, and varies almost momentarily. As an adjustment to this condition many plants are able to regulate the intensity of the light impinging on the chlorophyll-bearing masses of protoplasm by altering the position of the surfaces of the leaves. In others in which this movement is not possible—such, for example, as the leaflike duckweeds which float on the surface of the water—the intensity of the light received is regulated by alternations in the position and distance of the chlorophyll from the surface of the organ. (See Fig. 3.)

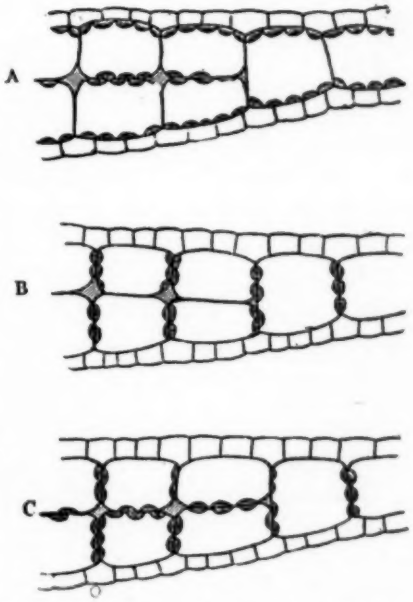

FIG. 3.—TRANSVERSE SECTIONS THROUGH THE FROND OF LEMNA TRISULCA (DUCKWEED), SHOWING DIFFERENT POSITIONS OF CHLOROPHYLL BODIES. A, position in diffuse light; B, in strong light striking the surface perpendicularly; C, in darkness.

In many plants growing in the bright glare of the sun a thickened cuticle or a heavy coat of hairs serves to protect the chloro-

phyll against the more intense action of the rays. It is also in this purpose of protection of the chlorophyll that many of the colors grouped under anthocyan find their chief function in the plant. In such instances the color is generally in solution in the sap of the layers of cells exterior to the chlorophyll, and light must pass through the coloring matter in order to reach the interior of the leaf. This may be seen by reference to Fig. 4, in which is shown a cross-section of a portion of a leaf of coleus.

That such layers of coloring matter do materially alter the light which passes through them may be demonstrated if the spectrum of light which has passed through a solution of them is examined in the manner described above. Water, instead of alcohol, is used as a solvent, however. If the color of the leaf of the amaranth is used, it will be found that nearly all the light has been absorbed except a portion between B and D (Fig. 1, II).

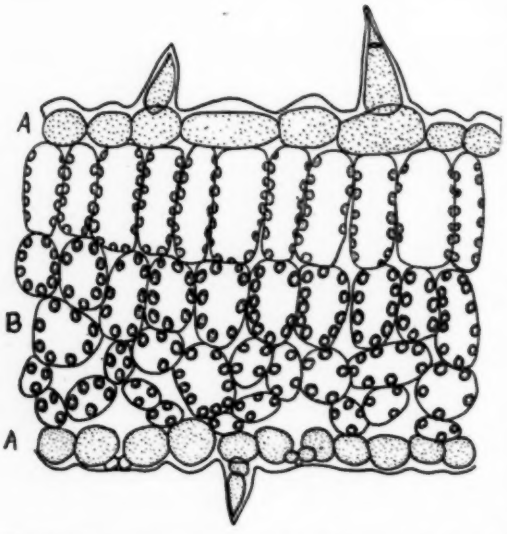

FIG. 4.—CROSS-SECTION OF LEAF OF COLEUS. A, A, epidermal cells filled with reddish cell sap; B, cells containing chlorophyll bodies.

It may be seen that a large proportion of the light is absorbed by the anthocyan and converted into heat, and furthermore it is inclusive of the portion of the spectrum which exercises the most violent disintegrating effect on chlorophyll, as may be seen by reference to Fig. 2. The portion which promotes synthesis of food materials, on the other hand, is transmitted almost unchanged to the chlorophyll beneath. That the anthocyan does partially retard the disintegration of chlorophyll by light may be seen if two vessels containing solutions of chlorophyll are so arranged that the light which strikes on one of them shall first pass through a parallel-walled vessel containing water, and that which strikes the other through a similar vessel containing a solution of anthocyan. The chlorophyll in the first will soon become much more discolored than in the second, which has received light transmitted through anthocyan. The number of plants in which coloring substance is present in the cell sap or walls of the outer layers of leaves is extremely large, and em-

braces many well-known species, among which are the "foliage" plants of the gardener.

A very large category of plants have become adapted to living in the deep recesses of swamps and jungles, and in underbrush, where the direct rays of the sun never penetrate. These plants must carry on the synthesis of food material by the aid of the diffuse light which reaches them, and stand a little danger from its over-intensity. Still another group is found upon the higher slopes of mountains in regions of low air temperatures. In both instances these plants need all the energy they may be able to derive from the light which falls upon them. They are not able by means of their chlorophyll to absorb all this light, and some of it would ordinarily be transmitted through the leaf without advantage to the plant. As an adaptation to this condition, their leaves are provided with layers of coloring matter, which are placed near the lower surfaces in such manner that any light passing the chlorophyll will be absorbed and converted into heat. It is noticeable that plants growing in the swamps and on the mountain tops are not provided with layers of coloring matter, if the leaves are arranged in such manner that light passing the upper leaves will fall on those underneath. The heat-saving color screen is not needed in this instance, but is present most frequently in leaves which form a low, simple rosette, or which lie close to the ground. That the presence of anthocyan in flowers is also often for the purpose of converting light into heat seems well authenticated, from the number of plants which bear colorless petals or glumes at ordinary temperatures, yet develop color in these organs at lower temperatures at the beginning or end of the season, or at higher altitudes. That these bright colors in living plants do convert light rays into heat follows as a conclusion of the following experiment devised by Kny: Three similar glass vessels with parallel walls were filled with distilled water. In one vessel a number of green leaves of canna were placed, and in another such number as to offer the same amount of surface as those in the first, but which contain a large amount of anthocyan. The third vessel is left unchanged, and all are placed in sunlight of equal intensity. A certain rise in temperature naturally ensues in the water in the third vessel; a greater rise occurs in the first, showing that chlorophyll converts a portion of the light into heat, while the greatest increase takes place in the second, where, in addition to the action of the chlorophyll, the converting power of the anthocyan is exerted. The difference between the temperature of the vessels containing the green and red leaves often amounts to 4° C., which is due entirely to the action of the anthocyan.

It is often necessary for the plant to transport complex food

substances from one portion of the vegetative tract to another along conduits which lie near the surface. On such compounds, as well as on chlorophyll, the blue-violet rays (see Fig. 2) exercise a disintegrating effect. In quite a large number of plants, the lines of vessels in stalks, midribs, and petioles of leaves are shielded from the direct action of such rays by means of external layers or bands of anthocyan, of some shade of red or purple. It is possible in some instances to trace the line of the conducting vessels by the lines of color appearing near the surface. The direct connection between the food substances and the presence of the coloring matter is strongly indicated by the example detailed by Kerner, in which the pearly-white rhizome of *Dentaria* when taken from the soil and exposed to the light will become a deep violet in a few hours. Whether the connection is a direct one or not, it is also true that many young and rapidly growing shoots exhibit marked reddish or violet colors at a time when reserve food is being conveyed to them in greatest quantity, and when the thin, tender tissues are otherwise so translucent as to allow the sun's rays to strike through them in a manner calculated to work great damage in the complex compounds in the young leaves. When the leaves mature and are not so pervious to light, the colors may disappear. This is well illustrated by the behavior of the young leaves of rhubarb, cherry, and grape. Many instances of this character are known, as well as the fact that storage organs are often provided with coloring layers or shields, when partially exposed to the light under normal conditions. In plants with deciduous leaves, or the shoots which die down to the root stock each year, it is highly important that the material in the protoplasmic structures of the portion dying away should not be entirely lost, as it represents a large outlay of energy. As a matter of fact, in plants of this character the protoplasm, chlorophyll, and other nitrogenous substances are usually broken down and begin to be gradually withdrawn into the surviving portion of the plant about the time of the formation of the first stages of the absciss layer which finally cuts off the leaf stalk, or about the time the activity of the herbaceous shoot begins to slow down. The disintegration of the chlorophyll would leave the leaf almost colorless and translucent, and the sun's rays would strike directly through it, resulting in the total decomposition of the proteids and a consequent waste to the plant, but during the decomposition of the chlorophyll there occurs, as a result or accompaniment of the process, the formation of much brilliant coloring matter of various shades, to which are due the brilliant autumnal tints of deciduous leaves. These coloring matters sustain the same general relation to sunlight as the other colors described above. They generally absorb the entire violet

end of the spectrum, which, as has been pointed out, is the one which causes disintegration in the cells, as well as the lower red and infra-red rays. The spectrum of the autumnal red coloring of the leaves of the Virginia creeper (*Ampelopsis*) is shown in Fig. 1, III. It may be safely asserted that the above-described occurrences of coloring matter are undoubtedly marked factors in the physiology of a large number of plants, without reference to the manner in which such coloring screens and shields have arisen. It is also true, however, that a large number of plants contain coloring matters in the interior of organs or disposed in such other manner that they could sustain no possible relation either to light or to animals furnished with a color sense; still, many other occurrences of color are to be noted in which a physiological function is quite possible but is not proved. Among the latter is the color formation which ensues in evergreen leaves on the approach of a cold season, or in other leaves on the approach of a dry season. It must be admitted that in some instances physiologists have been led to conclusions concerning the use of colors quite as little justified as many of those reached by enthusiastic students of "adaptation to insect visitors." It is now somewhat generally admitted that color substances must very often be regarded as simply by-products in the chemical processes carried on by plants; a view which is undeniably valid of color masses in the interior of underground roots or tubers, or massive aërial organs, and also in a large number of instances in flowers. This latter application is further justified by the fact that some flower colors may change during the season without any relation to light conditions, insect visitors, or other ecologic factors. It is quite within the range of possibility that color masses in aërial organs bear an important modifying relation to the forms of irritability to radiant energy acquired by the plant.

As a summation of the foregoing, it may be stated that coloring matters stand in the following relations to the plants:

1. Chlorophyll converts light into energy by the aid of which protoplasm containing it is able to build up foods from carbon dioxide and water.

2. Non-green coloring substances serve as a screen between the chlorophyll and the too violent rays of the sun, at the same time converting the absorbed portion of the rays into useful heat.

3. Non-green coloring substances convert the light which has passed the chlorophyll bodies into useful heat.

4. Coloring substances absorb the blue-violet rays and prevent their disintegrating effect on nitrogenous compounds *in situ* or *in transit* in the interior of the plant.

5. Non-green coloring substances are in some instances simply by-products or waste matter from the physiological processes, and

in the present stage of development and under ordinary conditions are of no use to the plant containing them.

6. Colors serve as an attractive, guiding, or warning device for insects and other animals, more especially for the purpose of securing cross-fertilization and protection from injury.

THE POLITICAL RIGHTS AND DUTIES OF WOMEN.

By GEORGE F. TALBOT.

THE political enfranchisement of women is so prominent a topic of discussion among all people that live under representative governments that no apology seems required for a contribution to the debate. It does not, however, seem necessary to recapitulate the arguments for and against the concession of the ballot to women—as if that alone was the ultimate or principal part of their demand—or to sum up and formulate any judicial finding on the basis of these arguments.

It is not difficult to perceive that the usual ground might be gone over, the usual arguments for woman suffrage stated and conceded, without touching any of the vital issues involved in the proposed change. The fact is, that the right to vote, in giving reasons against which the conservative thinker is always at disadvantage—always obliged to be more or less illogical and inconsistent—is not what is really asked, but something beyond it very much more radical and questionable. Let us see if we can not by an appeal secure from discontented womanhood a frank acknowledgment of the real *ultimatum* of demand, the specific redress of what is deemed the actual grievance.

There are two alternatives which might be proposed to the Woman Suffrage Association, or whatever other body has a right to represent the political demands of women:

1. Let the ballot be given to all women of full age who are citizens, with the condition, however, in the article or act itself in which this right is given, that they shall not be eligible to any executive, legislative, or judicial office, under the national, State, or municipal governments, except certain clerical and subordinate offices now open to women under custom or law, such as postmaster, register of deeds, member of school committee, etc.

2. Let such women as petition for it be admitted to full citizenship, with the right to vote and hold office, on proving their qualifications before the courts to whom jurisdiction over such petitions may be assigned. The judge listens to the application and the proof offered, that the petitioner is fairly intelligent, that her moral character is irreproachable, and she has not and is not

liable to have any domestic duties or relations which will disenable her from performance of all the employments which citizenship might impose upon her. To require her to hold herself liable to be drafted as a soldier in case of invasion or rebellion might not seem in these times of peace necessary, but that she could and would perform the duties of any office to which she would be liable by the very franchise she had sought to obtain, without pleading any exemption or disability due to her permanent condition as woman, would seem a not unreasonable requirement. If, in the discretion of the judge, she should successfully pass this preliminary examination, let her be admitted to full citizenship, with the right to be an elector, and to be elected to office on the same terms with men; while women generally, who do not desire even to vote, who are appalled at the thought of competing for office, and for whom the duties of any office are utterly incompatible with their fidelity as wives and mothers, are left in the political status which they prefer.

It is not assuming too much to anticipate that both these alternative propositions, if submitted as a definite settlement of the woman question to those persons of both sexes who, on either side of the Atlantic, have by their zeal and devotion earned the right to be considered as the leaders of what is called the *woman movement*, would be listened to with disdainful satire and scorn. It is avowed by all these persons, who speak frankly, that women want the ballot in order that they may become candidates and officeholders, and so be able in the interest of their own sex to affect local, State, and national legislation. We may, therefore, lay on the table the specific question of giving the ballot to women—leave it unsettled—conceding that, if it were only that, the matter might be arranged to meet the wishes of the petitioners, and confine ourselves in this discussion to the rights and qualifications of women to be the administrators of political power, and the effect which the exercise by women of those political functions now performed exclusively by men would have upon the welfare and character of women generally.

I. To the complete performance of such political functions there is this serious natural impediment: four fifths of the women all the world over, between the ages of twenty and sixty, are occupied with paramount domestic obligations quite incompatible with that integrity of devotion to public duties which all the great executive, judicial, and legislative offices demand of those who fill them. Under this disability of Nature, or closely related to it, all the objections to the exercise of political functions by women may be classed, so that no other objection need be considered. If the mother of a family of young children should give to the office of President, Governor, judge, or sheriff that entire

devotion of energy, time, and thought which her official oath exacted of her, she would be obliged to do it at the expense of that assiduous care, watchfulness, and service which her wifely and maternal relations demand.

Let us consider contingencies quite likely to occur under a *régime* which divided fairly between men and women the responsibilities of civic and public life. Would a husband of the city where this is written, going early to and returning late from his business—say that of chief salesman in a large retail store, or a contractor engaged in erecting a block of buildings—enjoy the honor of his wife's election to the Legislature, if while she were shut up in committee rooms with men, or interviewed at her lodgings by lobbyists, or waiting to mingle her shrill voice in the *mêlée* of a general debate in the House, the measles or the scarlatina should break out in the forlorn group of his motherless children? The banker, who had been harassed all day by the intelligence of a financial crash that threatened his own fortunes and the funds of widows and orphans of whom he was the trustee, would have a still stronger claim on the public sympathy if, coming home at night for fellowship and cheerful words, and asking his eldest daughter where her mother was, he should be told: "Oh, you know she is out on the jury with eleven men on that dreadful murder case, and it is not thought they can come in before morning."

I know the answer to this objection generally made: Yes, there are many women, as there are also some men, whose health, whose business, whose domestic cares, render them averse to office and exempt them from its responsibility. The good sense of the voters may be trusted not to select such engaged persons as candidates; and if they should be selected the good sense of the candidate can be trusted to decline the office, and that will end it.

But is this answer quite satisfactory? It is a question of reconsidering and readjusting the occupations respectively of men and women, which all civilized and uncivilized peoples, without concert among themselves, have established and built into their social institutions. An arrangement of this permanence and universality may be considered an arrangement of Nature. Nature evidently regards as of supreme importance the perpetuation of the race, and imposes presumably, and at least potentially, upon all women a paramount duty in accomplishing this purpose. The political disability, whether extending actually to four fifths of womankind or potentially to all womankind, is one irrevocably connected with that very office and *raison d'être*, which called woman into existence. An objection to employment in public office good as against four fifths of the female sex ought to be good as to the whole sex, just as if it were a question of enlisting women as soldiers, or shipping them as seamen, or engaging

them as miners or engineers—a disability affecting the greater number would be likely to disenable the whole.

This is the situation. The great body of men—the men in the prime of their physical and mental powers—have no employments or duties imposed upon them by Nature incompatible with the strict performance of the obligations of public office. A man may be a punctual and industrious executive officer, a studious judge, a commanding general successfully conducting a campaign, and be no whit less a faithful and helpful husband, a wise and provident father. This very excellence in these purely private and domestic virtues, while it would add to his popularity, would never be thought of as impairing his efficiency as a public servant.

Now it happens that women during the same period of their physical and mental prime are by their ruling instincts and their dominant sentiments assigned to duties which leave neither time nor faculty for any absorbing and responsible public station. It might be invidious to say that the best women are in this category of disability; it must be said, however, that the women whom men think the best—at least the best to be wives and the mothers of their children—are not eligible to public office.

In this actual condition of things what will be the probable result of sharing with all women, by a sweeping enfranchisement, the privileges of all political offices? Only those will be likely to be proposed as candidates, or at least will consent to be candidates, who have no incompatible domestic duties—unmarried women, who have no pleasant homes, or fathers, brothers, or sons with whom they can live harmoniously, and all the forlorn class, who have failed to come into agreeable relations with other persons, or who have made shipwreck of their domestic ventures. I question whether the great body of virtuous and intelligent women, the mothers, wives, and sisters of the citizens, would be so well satisfied to be represented by such persons as by those citizens themselves. Our domestic experiences appoint and maintain relations between women and men far more tender and intimate than are possible between women and women, or betwen men and other men.

Nor is the contingent disability one to be lightly overlooked. There hangs over the fortunes of every woman, at least during the early periods of her career, the liability to the *grande passion* that so greatly affects human destiny and character. Every housekeeper knows how precarious is the engagement of her domestic servant. If you have secured an exceptionally excellent person in your kitchen, and have begun to look forward to months and years of wholesome cooking and economic administration, along comes the inopportune lover and carries off your prize. You think her an admirable assistant; so does he, and

under the spell of his superior attraction your vision of domestic quiet and order vanishes. The same fortune befalls female clerks in stores, in banks, and in public offices, and teachers in all schools, public and private. Almost invariably we lose our clerks, our teachers, when they become wives; almost invariably we do not lose our clerks and teachers when they become husbands, never except when they pass to a higher grade of service or to partnership or an independent business.

> Love rules the court, the camp, the grove,
> And men below and saints above.

Let us suppose that in this congressional district, under the *régime* of full woman suffrage, some brilliant, educated, and accomplished lady, whose eloquence on the stump in a political campaign had electrified thousands of listening voters, had been nominated and elected as representative to Congress. Among the auditors whom she had fascinated might not one every-way eligible man have been bold enough to make confession of a personal attachment before the eloquent pleadings of which this young Jeanne d'Arc of politics should find herself compelled to forego her ambition for public distinction, and take upon herself the humbler but sweeter duty of consecration to a single man? The same accident would befall everywhere. Only the intelligent and agreeable women would be popular, and only the popular women would be candidates and elected. To put them in office would of itself expose them everywhere to appropriation by men brought by the occasions of public business into the circle of their acquaintance. I dare not pursue further this dangerous argument.

Will the female suffragists consent to a *self-denying ordinance* that shall exclude from office? I apprehend not. That is the very thing they will not listen to with patience. They have avowed that what they demand is that women shall have an opportunity to try their hands at law-making and law-administering, with a view of bettering both. They wish to vote in order that they may vote for each other, and no way has been proposed or seems practicable of making women electors that will not also make them potentially the elected.

As soon as the naturalized Irishmen in Portland became an appreciable element of the voting population, they began to be put upon the electoral tickets for municipal and State offices by both parties. In Boston and in New York, where they compose a majority of the voters, they get the majority of candidacies for places under the city government. When by a heroic effort we lifted a million of ignorant and degraded slaves to the rank of citizens and electors, the immediate result was negro justices of

the peace, negro judges of the courts, negro members of Congress, and in more than one State negro Legislatures, which proceeded in a summary way to confiscate the property of the late masters by taxation, ostensibly expended in public works and largely wasted by private plunder. If the effect of raising to the grade of voters the whole mass of illiterate slaves was to give them the whole political control of several States, why will not this complete enfranchisement of women give them the political control in all the older States, where they will be in the numerical majority?

If it be urged that the great body of women in this country have no taste for politics and do not desire office, and that their domestic duties exempt them from the responsibility of office, the same conditions might have been urged in behalf of the freedmen. They knew nothing about politics, did not care for office, and were under the necessity of earning their living and getting for themselves and their children homes, fortunes, and the rudiments of education. In that very condition a few bright colored men, native and immigrant, and many cunning white men, *carpet-bag* adventurers, intervened as the freedmen's special friends and took the offices the negroes could not hold. May not a like experience follow woman suffrage? A few restless women, mostly those whose domestic relations are out of gear or who have failed in a congenial social career, will find themselves at leisure to pose as nominees and candidates to represent their whole sex, and they will remember, in the distribution of such offices as they do not aspire for, those cunning men who, believing that the millennium of woman's rights was coming, had made themselves prominent in advocating them.

II. What wrongs are there affecting society which the women's vote and the political power it gives will set right? What disability or oppression does woman suffer at the hands of man, which she must rise in her physical might to redress? Every other agitation for social or political reform now rife, or that has been rife in my day, has been able to justify itself by a flagrant abuse repugnant to the universal sentiments of mankind. Slavery, intemperance, the poverty and privations that have been caused by unjust distribution of the products of industry—all these are palpable evils that denunciation can not exaggerate nor eloquence winged by strong emotion overstate. But the woman's grievance against man in these modern times, in any civilized country, what is it? The moment you begin to sum it up, the moment you undertake to tabulate and itemize it, you provoke the indignation of all generous and intelligent women. The moment you attempt to inflate its emptiness with the breath of invective you have to deal with hysteric fancies rather than hard facts, or consciously to enact a *make-believe*.

I am careful to say that woman has no grievance *against man*, I do not say she has no grievance. In common with all sentient creatures she does complain of the hard conditions of universal existence—conditions which it has been the long, slow effort of what we call civilization to amend and improve. The special hardship of the lot appointed to her by Nature is, that the pains, burdens, and weary cares that parentage imposes upon each generation, in order to provide for the succession of the race, have been unequally and cruelly laden upon one of the sexes. Through the long uncivilized ages, before man had wrung from niggard Nature any material comforts, any security against impending death, any leisure for thought, culture, or enjoyment, the conditions of the male and female were more nearly balanced in what each was called to endure. If on the latter fell the pangs of childbirth, and the long vigils of nurture for the feeblest younglings among living creatures, on the former came the brunt of internecine battles with fierce brutes and fiercer fellow-men. Civilization increasing the leisure, lightening the toil of man, and relieving him in a large degree from the wars in which he was mutilated and slain, has not been able, in any appreciable degree, to redeem woman from the primitive sufferings by which she consecrated her motherhood; and so the unequal fortunes of the two branches of the human race have become under the improved fortunes of the race more pronounced.

Woman does not put this into her bill of grievances, nor with her instinctive delicacy is she likely to do so. Symptoms that indicate disease sometimes mislead as to the character and actual seat of the disease. What woman will not ask for herself the respect and sense of justice of man must award her, and that is the complete sovereignty over all those functions engaged in the perpetuation of the race, insured by physical structure itself to the females of the inferior orders of living creatures. Woman has earned by her sufferings, by the enormous surplus of her contribution of time and strength and feeling to the maintenance of the family life, the right to control it, to initiate by her selection and the promptings of her own sentiments and preferences all its permitted intimacies. But all this, so difficult to formulate, must be left out in a discussion of a distinct though related subject.

Leaving out, then, whatever offense a cruel Nature has committed against woman, let us see if men have fairly acquitted themselves of their natural obligations to her. Take the present legal status of woman. Since men began to make laws they have made them for women, and in what situation has their deliberate sense of justice left women before the law? One after the other they have obliterated from the statute book all laws that discriminated against women in respect to their personal rights, and

to the acquirement, possession, and disposal of their property—old laws that had their origin in the barbaric spirit that made woman the slave of man, and, it must be confessed, which found no little sanction in that dogma of our accredited Christianity, which taught, too plainly to be misunderstood, that woman was as much below man in the scale of being as man was below the angels, her paramount duty being to be subject to him. But all this barbarism, Christian and un-Christian, has been swept away, and that too not by woman's suffrage, actual or prospective, nor by woman's petition or any political agitation prompted by her, but by man's own sense of equity and right.

No, women are not an oppressed class, least so in the United States, in England, in any country whose people have inherited the Teutonic sentiment which in the ancient Germany described by Tacitus made women counselors and advisers in the affairs of war, government, and business, as well as in matters purely domestic. *Women are a privileged class.*

When I say, and say after much careful thought, that women in this country are *a privileged class*, I have not in my mind those courtesies and civilities that have become established customs in all good society. I do not mean the respect which prompts all well-bred men to lift their hats to every woman of their acquaintance whom they pass in the street, that starts to his feet even the aged citizen when a robust girl gets into a horse-car or a thronged public meeting, even when the occasion of it may be to affect an election in which only men are concerned. All these are graceful offices for men to render, pleasant attentions for women to receive; but they are trivial, and to magnify them into substantial equivalents for political disfranchisement is to add insult to injury.

Let me make a brief inventory of some of the more substantial immunities and exemptions which women as women possess and enjoy, which mitigate for them the stress and strain of life, which affect their character, happiness, and destiny, as the usages and etiquette of social intercourse do not and can not, which, if not a compensation for political privileges, and for that excess of burden that maternity bears in caring for the perpetuation of the race, is a generous attempt on the part of men to make for their mates and yoke-fellows an easier pathway through a rugged world. To most of these exemptions and immunities the sex have become so accustomed that they are rather regarded as a part of the order of Nature than as a conventionality dictated by a generous sentiment.

III. Women are exempted from the perils, wounds, and deaths incident to war.

When we study man through his long history, we are compelled to confess that he is a fighting animal. Whatever other

employments he has had on this planet, he has been largely occupied in killing his fellow-men. We have looked forward to an impending millennium of peace for the world. We Americans have assured ourselves that our country, strong in wealth and in numbers and in its remoteness from the great warring nations of Europe constantly watching each other in arms, would never be engaged in those wars that have decimated the human race through the boasted ages of civilization and Christianization. But what has befallen us? Our grandfathers passed through the long and wasting War of Independence; our fathers—a favored generation—had only the brief British and Mexican Wars; and, to compensate for this immunity, there fell upon us, the grandchildren, one of the most destructive and bloody wars of history. To this war the State in which I live contributed seventy-two thousand men—more than a tenth of its population, two thirds of its arms-bearing people. So far, even in this asylum of peace, war has made its demand on the human life of each successive generation.

The requisition which wars have made upon human life during the comparatively brief historic period is something frightful to contemplate, and this requisition has been decidedly upon one sex. It is true that myriads of women and children have perished in the massacres, famines, and pestilences that have supplemented battles and sieges; but it was nevertheless always the chief care of the fighters on both sides not to expose their women to these casualties, and the first condition of making men courageous soldiers is to assure them of the safety of wives and children.

To what is the exemption of women from military service due? The hasty answer may be, to their physical and mental unfitness. The physical strength of the average woman is perhaps twenty per cent less than that of the average man. This disparity could be readily adjusted by adapting the labor and discipline of the two classes of recruits to it. Make the regulation musket for the female regiments twenty per cent lighter than the standard, and so the personal baggage; and if twenty miles is a fair day's march for men soldiers, require of the women soldiers but fifteen miles. The nerves of women might more quickly than those of men succumb to the terror of shot and shell, or of a bayonet charge, but actual wounds and mutilations they would endure with more patience.

In the few instances of an exceptional custom preserved in history, natural disability had ceased to be a factor. There is a Greek legend of the Amazons, a race of women in Asia, so formidable as to terrorize all the early Grecian settlements, and to require such valorous heroes as Bellerophon and Hercules to subdue them. Travelers more trustworthy than Baron Munchausen

tell us of an African king, whose standing army is of women—a fierce and terrible array.

It is even possible that in this judgment an effect has been mistaken for a cause. Women have not been exempted from military service on account of their congenital delicacy, but their characteristic delicacy is the slow result of their exemption from this and other hardships submitted to by men.

Certain phenomena open to general observation warn us that it will not do to trust too implicitly the permanence of natural laws, and that physical structure and accompanying mental endowments may be greatly modified by continued unfavorable environments. Among certain orders—the bee, for example—sex itself may be determined by a continuous special regimen and diet, when the exigencies of the community require it. Among domestic animals the cow, especially honored for the service rendered to men by her maternal functions, has been exempted from the yoke of labor and maintained in an indolent isolation of respect nearly equal to that of the queen bee in the hive. The result has been such a differentiation in bulk and build as almost to declare a difference of species between herself and her congener of the other sex. Among horses, sheep, and swine, a substantial uniformity of regimen and discipline brings the two sexes into physical conditions with no appreciable differences in size, form, and strength. So, too, with the carnivora: a community of employment, of exposure, of activity in predaceous warfare, tends to bring size, shape, and color into a uniformity of type, while among other wild orders, like the stag, the greater bulk, the exaggeration, of the parts serviceable in combats is clearly due to continuous fighting assigned to the males alone.

To what, then, must the anthropologist attribute that custom, almost immemorial and universal, which savage and civilized men have concurred in establishing, of exempting women from the service of fighting? To that which will be found to be the spring and source of most of their customs and institutions—sentiment; a sentiment in man of mingled pity, respect, and affection—a sentiment, like most others of somewhat low origin, beginning, it may be, in selfishness and the promptings of instinct, but flowering out in its complete evolution into a noble and divine virtue.

Facts of our own national history illustrate, if they do not confirm, this judgment. Our civil war called out, as I have already said, two thirds of the whole arms-bearing population of one State, and probably the same proportion for all the North. It called out three thirds of the arms-bearing people of the South. The war ended simply because one section had, and the other had not, a reserve of one third to fall back upon. Probably no two

peoples ever entered into a strife so fiercely and so unanimously as did the rebels, men and women, to win their independence, and the loyalists, men and women, to save the Union. And yet, earnest as we were in the struggle, recruiting our armies by volunteers, by enlistments, and by conscriptions; putting into the field patriots and scholars, citizens and aliens, philanthropists, clergymen, and criminals, and finally thousands of negro slaves, so deeply is the sentiment grounded in the heart of all civilized and savage men that women must not be put into the actual peril of battle, that the North would have given up the Union and the South its independence rather than have called into the field a single company of arms-bearing women.

There is plausibility in the contention that the ballot and the rule that the minority must submit to the majority are nothing but a development of primitive war. War puts all questions to the arbitrament of strength, and in the actual trial non-combatants do not count. The ballot is the count of the potential fighters, and presupposes and discounts a virtual combat. The right to rule belonging to the superior strength, the array of the combatants declares which is the stronger.

All through the earlier periods of English history, when some ambitious or reforming chief wished to get an obnoxious law repealed, or to displace an odious minister, or to change a hated dynasty, instead of starting newspapers, holding public discussions, and canvassing the country for votes, he summoned his retainers and fellow-chieftains to arms, took the field, and began to lay siege to towns and strongholds. The Government turned out its army and its adherents and met the malcontents in battle. If it was strong enough to overcome them, the leaders were beheaded and their estates confiscated, while the defeated followers were punished and dispersed. If the rebels were victorious, a new order succeeded—a new ministry, a new national policy, perhaps a new dynasty. All the great changes in government in England were effected in just this way down to the middle of the last century. In Mexico and the South American republics, though they have written Constitutions and periodic elections, voting seems to be considered a slow method of redressing grievances; the actual working system is *pronunciamientos*—that is, armed revolts against the administration in power, and the real *battle*, not yet evolved into the modern *ballot*.

Now, when the two forces—the one for, the other against, the Government—stood confronting each other, what could be more sensible than to anticipate and discount the result of the fighting? "How many fighting men," asks the loyal general, summoning a conference, "have you on your side?" "Fifteen thousand," replies the rebel chief. "Then why fight it out? for I have but ten

thousand, and yours are the best armed." Instead of a battle, there is a count of the combatants and a settlement in favor of the numerically stronger. So a count of the fighting forces took the place of a trial at arms, and the appeal to the majority of men capable of becoming soldiers, and so able to enforce their will against the weaker minority, took the place of insurrection as a method of political agitation. This view may not justify, but it does account for, the exclusion from enumeration in the class that decide political issues of the whole class of non-combatants.

IV. The next great immunity which, in recognition of the offices they exercise in the social system, and having its origin in the same sentiment, women enjoy, is exemption from all kinds of labor dangerous to life or exposing to hardship and privation. Thousands of men among all civilized and some barbarous people pass their lives from childhood to old age on the ocean as seamen. Their *terra firma* is the sloping deck of ships staggering through the restless billows, the sport of fickle winds. They fare hard; their sleep is liable to rude interruption; their toil, though not constant, is liable to crises of exertion and danger. At the word of command, enforced by brutal blows, they climb the slippery ropes or icy spars at the risk of being shaken into the boiling waves or, with fractured skulls, upon the reeling deck. This employment, from which women are excused, is only slightly less fatal to life than that of the soldier, and the ingenuity of man has devised no means considerably to lessen its annual roll of premature and appalling deaths.

In the same category belong those occupations that take thousands of workingmen into our northern forests, where they pass three months of each year contending with frosts and snows, sleeping upon hemlock boughs in smoky camps, and maintaining an exceptional vigor expended in continuous labor by the abundance of their rude fare. A shorter interval of more dangerous labor succeeds this long exile in the forest, when the timber the winter's industry has gathered is driven to the place of manufacture and sale through wide lakes and over dangerous rapids.

All the hard, repulsive, life-wearing work under ground in coal, mineral, and metallic mines is generally assigned to men, and they alone are exposed to those perils which beset engineers, train-men, the handlers of explosives, and the tenders of machinery.

It is certainly apparent that man, as the stronger sex, has not made an ungenerous use of his strength in his assignments. Having, in the right of his strength, the opportunity to determine the customs of society, he has taken upon himself, and exempted his mate from, all those vocations that expose to prema-

ture death or to great physical suffering, as well as those which segregate men from the social enjoyments of home and doom them to long exile in cold, storm, and darkness.

V. The last privilege of the sex—for only the great, cardinal privileges of womanhood need be enumerated—is woman's virtual exemption from the care of earning her livelihood and that of her offspring. Here, as in what has been said heretofore, I have disregarded exceptional and abnormal instances, and traced industrial and social customs, as men following the promptings of their dominant sentiments have been able to establish them. I have taken, too—and this seems legitimate—my illustrations from the most advanced types of civilization, rather than from the inchoate manhood of the savage and barbaric epochs and conditions. I do not forget to have seen women tugging baskets of manure to their miserable fields, or buried under burdens of hay, in Switzerland; nor the Sunday I drove by women mixing mortar and carrying hods of bricks up shaking ladders in the elegant city of Vienna; nor how all-prevalent poverty has equalized the lot of the two sexes in Russia.*

No law of social completeness is to be drawn from such exceptional instances. It is only on those broad lines where the instinctive tendencies of the dominant sex have not been hindered in their complete development by conditions imposed by primitive barbarism or slavery that the natural growth of a social status is to be studied.

But even in our times and among the most advanced races there are many exceptions to the general assignment to men of the primal care for daily bread. Very many men, through accident, sickness, and mental or moral incapacity, get disabled in the struggle for life, and the burden they were appointed to carry falls unnaturally upon a wife, a sister, a daughter. Widows carry on successfully the farms which a dead husband had cleared. Sisters take places in stores, in schools, engage as copyists, and contribute to periodicals, and so bring to the family fund the stipend which a deceased father, a dissipated husband, or an invalid brother ought to have earned. The social organism gets mutilated and wounded, and these are Nature's efforts at

* "The women are more diligent than the men; and the hardest work is often turned over to them, as is generally the case where peasant properties prevail. They are only 'females of the male,' and have few womanly qualities. They toil at the same task as men in the fields, ride astride like them, often without saddles; and the mortality is excessive among the neglected children, who are carried out into the fields, where the babies lie the whole day with a bough over them, and covered with flies, while the poor mother is at work. Eight out of ten children are said to die before ten years old in rural Russia."—(From a Review of F. P. Verney's Rural Life in Russia, in the Nineteenth Century, of January, 1887.)

recuperation and supply. In the healthy normal society—such as man establishes wherever he can—the true order seems to be that "man must work and woman must weep"—unless a cheerful temperament shall convert her weeping into a song, while waiting on the weariness of her yoke-fellow with affection and the ministry of a lighter service.

How few men in all civilized countries are from youth to old age exempt from the absorbing, imperious, ever-recurring necessity of earning the daily sustenance of themselves, of their wives, of the children they have dared to summon into a world bristling with hard conditions—a responsibility that sobers so many lives, and issues so often in insanity, suicide, or crime! If a census-taker should visit any day the homes of the *well-to-do* people of this or any other Eastern or Western American city, how would he be likely to find the sexes—of course, with the exceptions of idle men and too hard-working women—respectively employed? The men rise in the morning—some it may be leisurely and late—and go to their shops, their stores, their offices, their out-of-doors employments, spending the whole day in absorbing labor, the fruit of which tells directly upon the family income. If this mode of life, which becomes habit and routine, is ever interrupted, it is by some errand of business to Washington, to some commercial city, to the West, and, for a favored few, a genuine vacation of relaxation for two weeks at the mountains or the seaside. The women, after the oversight of the female laborers who perform the tasks of cook and chambermaid, and needle-work largely of an ornamental kind, pass the day in reading the magazines, the current novels, in the amateur practice of music or some other fine art, and in making and receiving social calls.

The understanding that custom has established in New England is, that when there are boys and girls in any well-conditioned family, the boys shall pass directly from school into some employment for wages, that shall occupy every working day of their lives; and that the girls shall be at liberty to cultivate their tastes and enjoy the pleasures of refined society, and be maintained by the labor past, present, and future of their fathers, their husbands, their brothers, or their sons. This is an arrangement that the modern man, following his controlling sentiments, has voluntarily made, and one that he insists shall be maintained. Accident, calamity, very often incapacity or vice, make men fail in the accomplishment of their generous purpose, and throw upon women unnaturally and abnormally the sterner cares and toils of earning the common livelihood. Men are defeated sometimes in realizing the careers that seemed open to their ambition; but these are exceptional cases, and social laws and tendencies are not

to be studied in their irregular and unusual development, but in their normal evolution.

If a capable and ambitious girl declares that she will teach school, or solicit a clerkship, or literary work in a newspaper office, or open a store, it will be the father and brothers who will protest, and not the mother and sisters. The men of the family are apt to feel that it will compromise their respectability if they have a daughter of the house earning anything. Fathers of sons and daughters have been reported, who have said: "I shall leave what little property I have to my girls, who will need it; the boys can take care of themselves." Many persons are cognizant of the fact that among their circle of acquaintance are a few men, high-spirited, conscientious, alive to the demands of nobly living, who have denied themselves the solace of marriage because they belonged to families where there were unmarried sisters, and the home could not be respectably maintained if their personal income was used in supporting another household.

VI. Now, putting any just valuation upon these great exemptions which the majority of women enjoy, and which all women enjoy so far as the appointment of men as a whole can predetermine their lot, can it be for a moment claimed that the position of women is one of *oppression*, and not of *privilege*?

I do not wish to say that men and women ever made a formal compact that the latter should surrender to the former all their natural political rights, as a condition for enjoying these privileges which have been awarded to them. None of the established customs of society, not even the forms of political government, were made in this artificial way. They were not made at all, but grew spontaneously. Rousseau's doctrine of a social contract is less in vogue than it was in the political philosophy of our fathers. But what I do wish emphatically to say is that, bargain or no bargain, the weaker sex has not been taken advantage of, and that its immunities and privileges are a full equivalent for all the political rights of which it may have been deprived.

For all the last century, perhaps for all the next, the stress and activity of the world have been and will be directed toward the development of a more pronounced individualism. Everybody is in intense pursuit of his *rights*. Everybody passionately asks: What of the common goods of existence can I appropriate to my own personal advantage and enjoyment? While this passion rules, nothing is to be expected but revolution and revulsion, the tearing down of the existing social and political institutions. When shall begin that more noble, more religious inquisition, not for *rights*, but for *duties*, when it shall be asked: What can I do to render some equivalent for the boon of life? What of my *rights* and my *possessions* can I surrender and sacrifice for the general

good? then will the era of social and political construction upon a grander order begin. Meantime, to the chorus of the citizen, the workingman, the serf, the slave, all accusing the old tyrannies of denied justice, is added the shrill note of "*insurgent*" womanhood—not universal womanhood, for universal womanhood, acquiescent and content in the spheres of service which her lot as wife and mother and other equally helpful relations to society give her, has not joined in the revolt.

The formula of the demand of "*insurgent*" womanhood is the ballot, but the ballot must be considered with all the power to make and administer the laws which it confers, with the probable changes in social customs it involves, and the new conditions it will present under which the struggle for life will go on.

I have assumed that the concession of the ballot, pure and simple, will not be satisfactory to those bodies that represent what is called the Woman's Cause. Senator Hoar, perhaps the most conspicuous man who has appeared as their champion, specially says: "I am quite willing to agree that no class of persons who are permitted to vote should be excluded as a class from holding office."

We may as well consider what changes in human society, and especially in the character and fortunes of woman, the new order of things sought to be inaugurated will be likely to bring about.

Immediately, and in one generation, not very many or considerable. Character, that has been slowly molded by certain influences, acting for long periods, will not be modified immediately by the withdrawal of those influences. Whatever deterioration occurs, whatever new hardships make the lot of woman more tragic, will only appear after adverse influences have had their full term of operation.

Neither in readjusting the duties toward society of the sexes respectively are men likely to insist that, in taking full political powers, women shall surrender any or all of their present immunities and privileges. The relation of the contracting parties is not one that will make any such rigid and hard bargain possible. But that surrender will inevitably be brought about by the indignant disdain of the women, who will have effected the social revolution, at being the recipients of any privileges which differentiate their situation or hamper them in their complete development. The inevitable ultimate result of subjecting the two human sexes to the same labors, the same employments, the same cares, will be just the same as when domestic animals have been subjected for long periods to the same conditions: sexual differences, physical and mental, will tend to disappear, and the two branches of the race will approximate a common type.

He has inadequately considered the nature of the demands

made by that section of womanhood in insurrection against the present social order, and the implications which lie behind their specific demands, who does not see the radical changes that will come finally as a result of conceding these demands. However disastrously the experiment may issue, the difficulties of either turning back or arresting the movement will be nearly insurmountable.

Certain discontented women say they want the ballot, in order that they may with it open to themselves, on the same terms and for the same compensation, a free career in all the professions and occupations in which men are engaged. They want to place all women in the condition of service and hardship in which the casualties of life and the precarious fortunes of business now place a few women. They wish to make wounds which the present social structure now receives here and there parts of its normal status. For they want to be lawyers and physicians charging the same fees, ministers having the same salaries, artisans and workmen having the same wages as men. The greater competition among the many women as against the few men in the occupations now open to women they propose to counteract by a statutory equalization of wages for the same kind of work.

The great labor crises and the imperiled industrial equilibrium in the whole civilized world being confessedly due to the excessive number of competitors for such paying work as machinery has left to be done, it is proposed to aggravate the situation by turning into the competition the whole mass of able-bodied women, not hitherto generally reckoned among the working class.

In the woman-suffrage movement the "insurgent women" virtually serve notice upon us men, that they do not desire any of our courtesies, which are a badge of their servitude, and that our politeness in giving them the best places in the concert room and the horse-car is superserviceable and compromises their sense of independence. They do not longer care to be petted or exempted from perils and hardships or to be maintained by labor not their own. They only want an equal chance to "*paddle their own canoe*" in quest of their own fortunes.

Whatever the answer to this demand may be, it will not be likely to be this: Very well, please yourselves; rough it with us in the struggle for life, asking no favors if such a contest invites you. Enlist in the military companies and stand the drill, and when the next war comes, go to the front. Join the fire company in your ward, and run with the machine, when the next fire calls you out at midnight. There is a ship in port bound round Cape Horn, on a year's voyage; the owners have had such bad luck with drunken men, that they mean to try a crew of

athletic girls. Go up the Penobscot and live next winter in a camp, and come back next spring balancing yourself with a pick-pole on the floating, slippery logs you have cut. Go down into the mines, and with your pickaxe and shovel dig coal and iron. Offer your services at the going wages to run a locomotive, to blast rocks, or handle dynamite.

Men who are husbands, fathers, and sons will not say this or anything like it. But when the lawyer finds his female competitor by the charms of her beauty and eloquence winning his clients; and the doctor, that the woman physician by her motherly tenderness has seduced his patients; and the minister, that some reverend lady by her superior sanctity has supplanted him in his parish; and all men in all their vocations, high and low, by whose toils they had gained bread for their families, are pressed with the competition of those it had been their chief spur to industry and their pride to maintain without the necessity of repulsive work, will not the feeling become universal that men are released from their obligations of duty and support toward the weaker sex?

The naturalists tell us that the human race acquired its strong parental affections by performing the needed offices of care and help which the prolonged infancy of its young—so much longer than among all lower animals—made necessary. We know that the tenderness, affection, and sympathy which are the essential grace and charm of womanhood, as well as the courage, disinterestedness, and chivalric sentiment which form the nobility of manhood, have sprung from that very relation of strong to weak, protector and protected, which have for ages subsisted among all the civilized races. What guarantee can they give us who are seeking to destroy that relation, or at least the cause and reason of its existence, that those cardinal virtues that adorn and dignify both sexes will not be involved in its destruction? For one, I should not dare to vote to drag woman from the high estate in which man honors himself in being her minister and servant, until at least the intelligent majority of women deliberately express their judgment in favor of a social change so consequential.

HARVARD COLLEGE OBSERVATORY has adopted the plan of sending out circulars to the scientific press and other interested parties, to announce discoveries as they are made, and secure earlier publication of them. The first of these circulars announces the discovery by Mrs. Fleming, from examination of the Draper memorial photographs, of a new star, *Nova Carinæ*, which appeared in the constellation Carina in the spring of 1895. A comparison of its spectrum with those of Nova Aurigæ and Nova Normæ shows close resemblance and apparent identity in essential features. Between April 8 and July 1, 1895, the photographic brightness of the star appears to have diminished from the eighth to the eleventh magnitude.

NATURAL SCIENCE IN A LITERARY EDUCATION.

By ALBERT H. TOLMAN,
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THE greatest forms of literature hold the mirror up to Nature —that is, to life. Literary conventions, even, go back at some point to real life. Because actual Sicilian shepherds once piped their happy songs where Theocritus heard them, the world has had its long line of pastoral poetry, an intolerable deal of the sack of empty repetition and formalism to one half pennyworth of the bread of reality. In spite of traditions, however, the more important literature of the world has kept in touch with actual life. Of Shakespeare and Chaucer we can confidently say that, though each had a library at home, he found another and a better one upon the street.

Modern science has invaded modern life; its devices meet us at every turn, its great conceptions fill our minds. What shall be the attitude toward science of those students who wish a literary education? Shall they devote themselves entirely to the study of the classic productions in the languages of ancient and modern nations? or shall they take up also those advancing lines of scientific investigation and speculation which are producing new instruments for everyday life and new themes for thought, and which are fashioning anew the very minds and language of men?

The clearness with which Wordsworth foresaw, in 1800, that poetry itself would in the time to come draw its subject-matter more and more from the domain of science, seems truly marvelous. He said in that year, in the preface which he wrote for the second edition of the Lyrical Ballads:

"If the labors of men of science should ever create any material revolution . . . in our condition and in the impressions which we habitually receive, the poet will sleep then no more than at present; he will be ready to follow the steps of the man of science. . . . The remotest discoveries of the chemist, the botanist, or mineralogist will be as proper objects of the poet's art as any upon which it can be employed, if the time should ever come when these things shall be familiar to us, and the relations under which they are contemplated by the followers of these respective sciences shall be manifestly and palpably material to us as enjoying and suffering beings. If the time should ever come when what is now called science, thus familiarized to men, shall be ready to put on, as it were, a form of flesh and blood, the poet will lend his divine spirit to aid the transfiguration, and will welcome the being thus produced as a dear and genuine inmate of the household of man."

The literature of an age takes up into itself the whole mental life of the time. He who would adequately interpret modern literature should know modern life, and in that life science is a marked element. A general knowledge of contemporary science is needed to interpret contemporary literature. Tennyson, for example, constantly refers to the great scientific discoveries and conceptions of his time. How shall a reader ignorant of those conceptions fully appreciate him? Prof. William H. Hudson, in a remarkable article,* speaks of "Tennyson's keen interest in science; his sympathetic hold upon the vast movements in progress around him; his manly attitude toward the changes that life and thought were everywhere undergoing." Even the casual reader of Tennyson must have noted how deep is his interest in scientific study, and how fully the great conceptions of modern science find expression in his poetry. Indeed, there seems to be a prophetic element in this. As Miss Scudder notes in her recent volume,† it is hard to realize in reading some parts of In Memoriam that it was published in 1850, nine years before Darwin's Origin of Species.

Great forms of thought, mighty molds which of necessity give shape to our thinking and then to our very imaginings—these come to us from the study of things, not from the study of language. Literature itself must largely find its raw material, its great metaphors and similes, its vivid pictures and mighty symbols, within the domain of natural science, and this increasingly as the years go by. The chemist's law of definite and multiple proportions; the laws of motion; the phenomena and laws of light, heat, and electricity; the strata, the glaciers, and the processes of earth-sculpture of the geologist; the winds, tides, and ocean currents; the theories of animal evolution; the struggle for existence, the survival of the fittest; the mighty phenomena, the impressive uniformities, the nebular hypothesis of astronomy —these are great forms of thought as well as facts and theories of science. A man who is unacquainted with modern science can not well understand the language of educated men, and he can not interpret sympathetically and adequately the literature of his own day. Were any writer completely ignorant of these facts and conceptions, he would be unable to make use of some of the most powerful symbols that exist for the expression of ideas. Standing in the midst of a mighty speaking universe, he would find himself, in a measure, tongue-tied because deaf.

Prof. Drummond's suggestive book, Natural Law in the Spiritual World, shows what powerful instruments science furnishes

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* Poetry and Science, Popular Science Monthly, October, 1894.

† The Life of the Spirit in the Modern English Poets.

for the exposition and enforcement of thought. The fundamental importance to the speaker and writer of finding effective symbols for his thought is perhaps best illustrated by the parables of Christ; "without a parable spake he not unto them."

The larger facts of modern science constitute an incomparable challenge and stimulus to the imagination. The electric thrill circles the earth ere a swift-footed Achilles could gird up his loins to run. An instructor in rhetoric in the University of Chicago recently stated that the most vivid and imaginative themes which came to him from a certain class were written by some pupils interested in geology upon simple topics connected with the history of the earth. Some of the great writers of coming days are already

> . . . nourishing a youth sublime
> With the fairy tales of science.

The value of scientific study is not to be measured, of course, by the extent to which it ministers to the production and appreciation of good literature. The necessity of some knowledge of science, in order that the educated man may possess his intellectual birthright as a member of his own generation, furnishes a fundamental and unanswerable argument for such study. That ideal of education will never go entirely out of fashion which demands that each student make a brave and earnest attempt, even though it can never be more than partially successful, "to see life steadily, and see it whole." This ideal will always appeal to some minds, and its advocates will judge colleges and universities by their success in furnishing education of this type.

Is there any practical difficulty besides the obvious limitations of time and strength which prevents students of literature from obtaining an outline knowledge of the more important branches of modern science? Unquestionably, the great difficulty is a conviction on the part of these students themselves that scientific study is without value for them. But in some cases this is not the only obstacle. Some of the introductory courses in science in the American institutions of collegiate grade seem to be planned for those who wish to make specialties of the sciences. Brief, synoptic culture courses—such as can be covered, let us say, by means of a daily class exercise for a period of twelve weeks—are accessible in many institutions, and sometimes in all of the major sciences; but in other cases they are disbelieved in and are not offered. In study of this sort, of course, two or three hours of field or laboratory work often take the place of a lecture or recitation. Sometimes the first course in a particular science, while brief enough to come under the description given above, is evidently planned entirely as "first steps," not as a synoptic course that shall by itself minister to a broad culture.

I grant that literary students should study some one fundamental science more fully than I have indicated, as a guard against habits of superficiality; but if they are to make any such acquaintance as it seems to me that they should with the "circle of the sciences," it must be by means of synoptic culture courses, since their literary studies will of necessity claim most of their time.

Some scientists will think my proposal foolish and impracticable. It will seem to them absurd that a man should try to study chemistry, for example, especially on the side of its value for mental culture; that he should be vitally interested in the fundamental facts of metallurgy, in the law of definite and multiple proportions, and the atomic theory, and have only a very languid interest in bad smells and the details of the chemical laboratory. But I know that there are scientists whose standing is unquestioned who believe in the value and practicability of the courses that I am advocating.

Undoubtedly some work in natural science can be satisfactorily accomplished in the schools preparatory to college. The more external study of plants and animals should be made prominent here. Ornithology in particular, now that Mr. Chapman's admirable handbook and helpful works by others have been published, may well furnish delight and refreshment to the youth of the present and coming generations. Who can fail to be interested in birds—in voiced sunshine and winged music—especially when the appeal is re-enforced by such writers as John Burroughs, Olive Thorne Miller, Bradford Torrey, and Frank Bolles?

I can not think, however, that other branches of natural science can be handled in a manner adequate to the needs of a broad education in the secondary schools. A certain preparedness of mind for college courses and a very moderate amount of acquirement seem to be all that can be expected in many departments of science from such preparatory work; but I am not entitled to have a very definite opinion on this point.

If I say a few words in favor of natural science as a mental discipline, I shall take a line of argument that is not now popular. Still, the educational world has its fashions. Our present way of thinking, therefore, may change, at least to some degree; and mental discipline in education, the old idea of to-day, may become one of the new ideas of to-morrow.

Since Harvard University gave to its undergraduates practically complete freedom in the choice of the courses which lead to something that it was nevertheless decided to call the A. B. degree, the principle of election in undergraduate study has had free course and been glorified. Some persons would even claim that the various departments of study are substantially equal and identical in disciplinary power and general educational value.

This proposition I can not accept. Literature, for example, is an indispensable element in an education, but it does not give all kinds of knowledge and mental training. Those students who look upon literature as in itself an education will find—or others will find it out if they do not—that they have accepted it in some measure instead of an education. One can not omit the other great subjects from his training, and then make up for their loss by reading his Browning, his Chaucer, or even his Shakespeare, more often and more strenuously. The mathematics and the more exact physical sciences help, as no other branches of study can, to give to the mind habits of accuracy and a sense of proportion. In a class in literature many questions do not admit of exact answers; the personal element must come in; the answers of the most careful instructor are only an approximation to the truth; the answers of the most superficial scholar will not be entirely wrong. Indeed, since a literary masterpiece makes its appeal primarily to the emotions and the imagination, the whole conception of definite, exact answers to specific questions has but a limited application to the work of the class in literature. In mathematics and the more exact physical sciences each problem is specific, and has one answer that is exactly right; all other possible answers are exactly and entirely wrong. Every man needs the discipline of such study.

Let the man interested in literature study mechanics. When he learns that many forces differing in quantity and direction can all combine in a single resultant motion, he will not be quite so ready in studying literary movements to fix the attention upon one force or circumstance and neglect all the others. Let him study chemistry; let him determine all the elements in a given compound, and how much of each is present; then he will not be quite so apt, when analyzing a piece of literature, to fix the attention upon one quality and ignore everything else.

Even professional literary critics are often decidedly lacking in proportion, poise, and sharpness of outline. Let me illustrate. Mr. Swinburne speaks thus of Collins: "He could put more spirit of color into a single stroke, more breath of music into a single note, than could all the rest of his generation into all the labors of their lives."* The same critic comments as follows upon some of the poems of Keats: "The Ode to a Nightingale, one of the final masterpieces of human work in all time and for all ages, is immediately preceded in all editions now current by some of the most vulgar and fulsome doggerel ever whimpered by a vapid and effeminate rhymester in the sickly stage of whelphood."†

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* Ward's English Poets, iii, p. 282.

† Encyclopædia Britannica, article upon Keats.

I do not care now to object to the qualitative judgments here expressed; but how about the quantity of praise and blame that is bestowed? Is it probable that the writer of these words ever had much thorough training in the mathematics and physical sciences? Indeed, can he ever have studied anything quantitatively?

It is not my main purpose, however, to argue for the disciplinary value of scientific study; its more direct and substantive value for the student of literature is what I have wished especially to set forth. There seem to be two great types of collegiate education, the literary and the scientific. That natural science has an important rôle to play in the ideal literary education I firmly believe; and in support of this position I appeal to the prophecy of Wordsworth, to the poetry of Tennyson, and to the reason of the case.

RECENT WORK ON THE X RAYS.

THE general interest which the so-called Röntgen rays have excited among the unscientific as well as among the specialists seems to justify a more extended treatment than their actual value to humanity, so far as at present known, would warrant. The following extracts are taken from the published statements of some of the more prominent physicists. They are more or less tentative, as all such work at present must necessarily be; but they are of interest, as showing the lines along which experimentation is going on, and they perhaps offer some indication of the probable future of this curious form of energy.

In a paper read before the Paris Academy of Sciences M. Jean Perrin says: "Two hypotheses have been propounded to explain the properties of the cathode rays. Some physicists think with Goldstein, Hertz, and Lenard, that this phenomenon is, like light, due to vibrations of the ether, or even that it is light of short wave length. It is easily understood that such waves may have a rectilinear path, excite phosphorescence, and affect photographic plates. Others think, with Crookes and J. J. Thompson, that these rays are formed by matter which is negatively charged and moving with great velocity, and on this hypothesis their mechanical properties, as well as the manner in which they become curved in a magnetic field, are readily explicable." A series of experiments which the author made, and which are given in Nature for January 30th, lead him to the following conclusions. "These results as a whole do not appear capable of being easily reconciled with the theory which regards the cathode rays as being ultra-violet light. On the other hand, they agree well with the theory which regards

them as a material radiation, and which, as it appears to me, might be thus enunciated. In the neighborhood of the cathode, the electric field is sufficiently intense to break into pieces (into *ions*) certain of the molecules of the residual gas. The negative ions move toward the region where the potential is increasing, acquire a considerable speed, and form the cathode rays; their electric charge, and consequently their mass (at the rate of one valence-gramme for a hundred thousand coulombs), is easily measurable. The positive ions move in the opposite direction; they form a diffused brush, sensitive to the magnet, and not a radiation in the correct sense of the word."

Nikola Tesla, in a recent Electrical Review, describes the following experiment, which seems to support the view that these rays are material radiations: When an exhausted bulb is attached to the terminal of a disruptive coil, small streamers are observed which often break through the side of the bulb, producing a fine hole. "Now, the extraordinary thing is that, in spite of the connection to the outer atmosphere, the air can not rush into the bulb as long as the hole is very small. The glass at the place where the rupture is may grow very hot—to such a degree as to soften; but it will not collapse, but rather *bulge out*, showing that a pressure from the inside greater than that of the atmosphere exists. On frequent occasions the hole becomes so large as to be perfectly distinguishable to the eye. As the matter is expelled from the bulb the rarefaction increases and the streamer becomes less and less intense, whereupon the glass closes again, hermetically sealing the opening." He reports producing strong pictures at a distance of forty feet by the use of a bulb with a single terminal, which permits the use of practically any desired potential.

An account of some important experiments by L. Benoist and D. Hurmuzeson appears in the *Comptes Rendus*. They caused the rays of a Crookes tube, incited by a powerful coil, to act upon the gold leaves of a Hurmuzeson electroscope at the distance of about twenty centimetres from the tube, and alternately charged with positive and negative electricity. The insulation obtained by a disk of dielectrine which closes the tube admits of the perfect preservation of its charge for several months. The X rays immediately and completely discharge the electroscope, more rapidly if the charge is negative than if it is positive. "We have thus," they say, "a new way of investigation applicable to the study of these rays, and enabling us to gain important information as to their real nature. The plate to be studied being put in its place, the electroscope charged to about a divergence of forty degrees, the keeping tube replaced, and the Crookes tube set in activity, we have observed:

"1. Black paper (sixteen leaves interposed). The collapse of the gold leaves is immediate and complete in a few seconds; they do not rise again. 2. Plate of brass (two tenths of a millimetre in thickness). No change in the divergence of the gold leaves. 3. Plate of aluminum (one tenth of a millimetre). Immediate fall, complete in a few seconds; same result with plates of aluminum up to one millimetre, and even upward, and the Crookes tube being removed to the distance of thirty centimetres. The substances easily traversed are silver in beaten leaves, leaves of paper steeped in metallic solutions, vulcanized fiber, gelatin, celluloid, ebonite, etc. The substances not traversed, at least in the thicknesses employed, are brass, zinc, glass, and unglazed porcelain (three millimetres). Similar results have since been announced from several other investigators."

A paper by G. Jaumann, under the title of Longitudinal Light, is described in Nature: "It is based upon the law of electric discharge enunciated by Jaumann in 1888, according to which electric rays impinging at right angles upon a cathode surface favor the dissipation of the charge upon it. Hence, the writer argues, light vibrations must have a component in the direction of propagation; they must, in fact, contain longitudinal as well as transverse waves. It then becomes a question of how Maxwell's electro-magnetic equations, which do not admit of any but purely transverse vibrations, can be made to agree with these conclusions. Jaumann gives a simple answer. Let it be admitted that the specific induction capacity of a medium and its magnetic permeability are affected by the oscillations themselves. These 'constants' will then be variable, and when introduced as such into the equations longitudinal vibrations are at once seen to be possible. Each pencil of light will then be vibrating transversely along its center line, and toward the outer edge the vibrations will become more and more longitudinal. The author claims that this theory affords a natural and simple explanation of a large number of discharge phenomena."

Prof. Oliver Lodge, of University College, Liverpool, is reported as having said that he felt inclined to adopt the view that the new rays were longitudinal waves in the ether; and that if this were so the discovery would open up a department of physics as large as light, sound, or electricity. Later, in a letter to Nature, discussing the theory of the anodal origin of the X rays, he says: "The term 'anode rays' for the rays discovered with so much *éclat* by Prof. Röntgen, whether they be the same as those previously discovered by Dr. Lenard or not, is suggested by the remarks of Mr. A. W. Porter at a recent meeting of the Royal Society. They certainly do not start from the cathode, but from some opposed surface—a surface which may be an actual anode,

and which always has some anodic properties. From each point of such a surface rays start in all directions; this is proved by the shadows they cast of slits, holes, and wires."

Prof. S. P. Thompson takes exception to the term anodic, as applied to the X rays. He says: "Is it quite correct, as Prof. Lodge puts it, to call the X rays anodic, because they start from a point opposite the cathode? It may be true that a surface upon which the cathodic discharges are being directed acquires thereby some properties common to the anode, but it is not an actual anode; . . . hence I submit that *anti-cathodic* would be a more correct term to use in describing them."

Prof. A. W. Porter, of University College, London, in a letter to Nature, says: "In your last issue, in the account of the work in the *Comptes Rendus*, you state that M. de Heen 'proves conclusively that the X rays proceed from the anode and not the cathode.' May I point out that I have proved that this is undoubtedly true for the bulb I have been using *throughout* my experiments on the X radiation? The bulb is one in which the negative electrode is concave, and the negative stream is thereby focused to a point on the anode, which is a platinic disk placed near the center of the bulb. By measuring the positions of different parts of a radiograph of a series of concentric zones of tin foil placed in a measured position, I have shown that the actinic rays diverge from the anode disk."

It was announced from Rome that Prof. Salvioni, of Perugia, had discovered a means by which these radiations could be made to so far assist the eye as to enable it to see through all objects which the rays could penetrate, so that the contents of a closed space were revealed.

From Prof. Salvioni's description of the apparatus, which follows, it will be seen that he has made no new discovery, and that it is quite incorrect to say that the observer actually sees the objects. He simply sees the shadows on the phosphorescent screen. The fluorescent light affects the retina like ordinary light, and is quite distinct from the X rays. What is really seen is a shadow picture of the object.

The apparatus is very simple, and is thus described by Prof. Salvioni: "This cryptoscope consists of a small cardboard tube about eight centimetres high. One end is closed by a sheet of black paper, on which is spread a layer of fish glue and calcium sulphide; this substance I have found to be very phosphorescent under the action of Röntgen rays. Within the cardboard tube, at the other end, at which the eye is placed, is fixed a lens, giving a clear image of the phosphorescent paper. On looking through this cryptoscope one can see, even in a light room, the shape and position of metallic bodies inclosed in boxes of cardboard, wood,

aluminum, and within the flesh." These experiments have since been repeated by many other investigators with perfect success; the observer in one case examining the bones of his own hand.

Gustave le Bon, in the *Revue Scientifique*, in summing up the results of his experiments on the X rays, says: "These experiments, which have been varied in all ways, are fundamental. They show us that the degree of thickness of the opaque plates is absolutely without importance in the passage of the '*lumière noire*.' They also indicate that the '*lumière noire*' is propagated under other laws than those which govern ordinary light. . . . This light can be transformed into radiations which propagate themselves as electric currents. They are not, however, electric radiations, because they produce effects which ordinary electric currents will not produce. We find ourselves, then, in the presence of a form of energy which is not light, as it only has part of light's properties and does not obey the laws of the propagation of light, and which is not electricity, since electricity in all known forms does not produce the same effects. The '*lumière noire*' must be considered as a new force added to the few of these which we already know."

In a letter to Nature, Lord Blytheswood describes the following experiment with a Wimshurst electrical machine of one hundred and twenty-eight three-foot plates, the machine being driven by a motor of about one horse power and a half. "A thick sheet of lead was placed upright between the poles of the electric machine, as a screen, and was connected to the ground, the two poles being insulated. A sensitive dry plate was put into the camera dark slide, with a metallic object to be photographed (a steel washer with holes in it), and this was connected by a wire which passed out of the dark slide to the ground. The whole was wrapped up in four folds of a black velvet focusing cloth, and was put in some cases between the negative pole and the lead screen, and in other cases between the positive pole and the lead screen, the plane of the slide being perpendicular to the line of discharge. In all cases good strong negatives were obtained with exposures of about twenty minutes. The machine was arranged to give a silent brush discharge during the experiments." Several other physicists have reported obtaining shadow pictures without the aid of a Crookes tube, by using an electric current or simple sunlight, and a fluorescent screen, after very long exposures. Henri Becquerel recounts the following interesting experiment: "I inclose a photographic plate in two folds of very thick paper, so that the plate does not become shaded on exposure to the sun for a day. On the outside of this paper a plate of phosphorescent material is placed, and the whole is exposed to the direct rays of the sun for several hours. When the plate is developed we find

that the silhouette of the phosphorescent substance appears in black on the proof. If a coin is interposed between the phosphorescent substance and the paper, its image appears on the proof. A thin sheet of glass may be interposed to preclude the possibility of chemical action."

It is announced by Mr. Edison that calcium tungstate (properly crystallized) gives a splendid fluorescence with the Röntgen rays, far exceeding that of platino-cyanide.

A rather ingenious explanation of the X rays is offered by Mr. J. W. Gifford. He likens the Crookes tube to a vibrating tuning fork, which, if sounding simple A, would set an A violin string vibrating not only A but its octave and the fifth to its octave, and quite a host of other overtones or harmonics of rapidly decreasing wave length which would seem to have no theoretical limit. The waves of long period from a Crookes tube would pass through wood, paper, or the human body, without much resistance, but would be absorbed or reflected by the denser metals. But if objects capable of taking up their vibrations lay in the path of these long rays they would set them vibrating like the violin string, and might in the same way produce overtones which did not before exist. These overtones may include waves of such short lengths as to cause the objects themselves to become luminous. If so, the light waves in question, although they are distinctly instrumental in darkening a photographic plate exposed to them, have nevertheless not passed through, and could never pass through the obstacles easily traversed by the electric waves which gave them origin.

Prof. Ogden N. Rood, of Columbia College, has quite recently published in Science an account of some important work on the reflection of these "rays." The mirror used was a new sheet of ordinary platinum foil. Great care was taken to prevent any rectilinear emanations from the discharge tube reaching the sensitive plate, which was contained in an ordinary plate holder, being covered with two sheets of aluminum, each 0·17 millimetre in thickness, and the draw slide, and over the whole was fastened a netting of iron wire. "After an exposure of ten hours it was found that a good image of the netting had been produced on the vertical strip of the plate exposed to the reflected rays. This image had various deformations, the vertical lines representing the netting being, as a general thing, most distinct; in some places, however, the horizontal lines had the upper hand, and there were a few spots where both were equally distinct. These facts and the character of the deformations point very strongly to the conclusion that in the act of reflection from a metallic surface the Röntgen rays behave like ordinary light." Further experiments were made to ascertain the percentage of the rays

reflected. The result arrived at, which Prof. Rood says is only to be regarded as a first approximation, was that platinum foil reflects the one two-hundred-and-sixtieth part of the X rays incident on it at an angle of forty-five degrees. Prof. G. Vicentini and Dr. G. Pacher, in a paper read before the Reale Istituto Veneto di Scienze, report having found distinct evidence of an irregular refraction from a parabolic brass mirror.

Regarding the value of these rays in surgery there are at present hardly sufficient data to warrant a positive conclusion. However, a most thorough and profusely illustrated article appeared in the American Journal of the Medical Sciences for March, 1896, entitled The Clinical Application of the Röntgen Rays. It is much the best exposition which this branch of the subject has yet received, and if one can depend on the pictures, the now agent promises to be, if nothing more, at least a great aid to diagnosis.

An interesting commercial application of the rays is announced by Bugnet and Goscard in the *Comptes Rendus*. "The proofs which we have the honor to submit to the Academy show in juxtaposition silhouettes of genuine diamonds and of imitations, both loose and set. Prolonged exposure soon succeeds in causing the silhouettes of genuine diamonds to disappear, while false diamonds continue to behave like opaque substances. The same procedure has also enabled us to distinguish natural jet from its mineral imitation."

At a meeting of the Royal Society, on February 13th papers on the Röntgen rays were read by Lord Kelvin and Prof. J. J. Thompson. A discussion followed, the general tone of which showed that, although many interesting points have been cleared up, there is still considerable difference of opinion among the authorities regarding fundamentals, and, while extremely valuable experimental work has been done, we are yet far from a final explanation of the origin and properties of this new (?) form of energy.

The following, from an unbeliever, may perhaps be of interest: Ch. V. Zenger says, in speaking of some pictures obtained by Domalip, Professor of Electrotechnics at the Polytechnicum of Prague: "The interesting point is that Domalip has obtained electric images on a plate by means of plates of copper, brass, zinc, lead, and steel. This is, in my opinion, the proof that there is here merely a phenomenon of electric induction producing phosphorescence of the gelatin, and at the same time an electric discharge in the gelatin, and, lastly, the fluorescence of the ambient air, and as in case of the dark discharge of electricity. In my opinion, these are the three agents which determine the decomposition of the silver salts in the sensitive layer. There are no special radiations, no X rays, and no dark light."

SKETCH OF HENRY AUGUSTUS ROWLAND.

By CHARLES EDWARD LLOYD.

AMONG the distinguished physicists America has produced Prof. HENRY AUGUSTUS ROWLAND, of Johns Hopkins University is unanimously accorded a leading place. He was born at Honesdale, Pa., November 27, 1848. His forefathers were among the earliest settlers of Fairfield, Conn. Three generations of clergymen of well-known prominence in the Congregationalist Church of Windsor, Conn., are his immediate paternal ancestors. His father, the Rev. Henry Augustus Rowland, had a great love for all scientific pursuits, and only gave them up for what he considered a higher calling. Prof. Rowland's mother is descended from representatives of several Knickerbocker families of Manhattan Island. She was Harriette Heyer, the daughter of a wealthy merchant of New York. Her mother was Miss Suydam.

In 1855 Prof. Rowland's father removed to Newark, N. J. He died there in 1859. Prior to his death, however, he had discovered the scientific bent of his young son, and heartily sympathized with and encouraged it. During the residence of his family in Newark the boy spent most of his time making chemical experiments. He used a book on chemistry belonging to an older sister, and worked in a crude laboratory he made for himself in the cellar of his father's house. Between the ages of eleven and fifteen he also commenced experiments in electricity and magnetism, making many small electric motors, electric machines, and repeating all the experiments he could find mentioned in the few scientific books to which he had access.

When he was about sixteen years old his mother sent him to Andover, Mass., to prepare for college. While here he was so engrossed in his electrical and magnetic experiments that his Greek and Latin studies were neglected. He was severely reprimanded by Mr. Taylor, the head of the school. This lecture, delivered to him in an arbitrary manner, without any inquiry as to the cause and with no word of kindness or sympathy, made a profound impression on the boy and increased, if possible, his dislike for the stones of the Latin and Greek languages which were forced upon him when he was starving for the bread of scientific knowledge. On returning home from Andover he expressed his dislike for this course of study so strongly to his mother that she determined to send him to the Rensselaer Polytechnic Institute at Troy, N. Y., at that time the leading engineering school in the country. Here the young man maintained a good position in his classes, although much of his time was spent in his own experi-

ments and studies. The subjects taught, however, were so congenial to him that one reading of the lessons assigned him was sufficient to insure a creditable recitation.

Owing to an injury to his knee during a snowball fight, he gave up his classes in Troy and studied chemistry for half a year at the Sheffield Scientific School. Here he invented and made the first continuous current dynamo ever constructed, which has since been exhibited at the World's Fair at Chicago. Young as he was, he was busily engaged in researches and experiments on magnetism. He was an earnest student of Faraday's Researches, Tyndall's Heat, Youmans's Conservation of Energy, and books of similar nature, although he had never studied the subject of physics under a competent teacher.

He returned to Troy and was graduated in 1870 with the degree of C. E. On his return home he continued to work on his favorite subjects of electricity and magnetism. About this time he published his first paper, a letter to the Scientific American describing a visit to an inventor, who professed to obtain great power from a single cell of a battery. Mr. Rowland, being familiar with the laws of the conservation of energy, knew there must be some swindling device somewhere, and finally exposed it, although a number of capitalists had already been defrauded of large sums of money by this man's claims. For part of a year Mr. Rowland was connected with a railroad in western New York as civil engineer, but routine work of this nature was so distasteful to him that he accepted the place of Instructor in Natural Science in Wooster University in Ohio. After a few months' experience here, he went to Troy, N. Y., to teach physics. During this period he had been engaged in researches on magnetic distribution, and what is now called magnetic permeability, using a system of absolute magnetic units of his own invention and calculating many cases of magnetic distribution by the method of the magnetic circuit, now always used for the calculation of dynamos and motors, and often ascribed to Hopkinson, but really due to Rowland. These researches he rewrote three separate times, and sent for three consecutive years to the leading scientific journal of America. Each time the editor, who was not a physicist, said that he had consulted the most eminent physicists of the country, and their advice to Mr. Rowland was that he had better study the subject before attempting to write any more papers. This criticism naturally discouraged and depressed the ambitious and studious man. Since his earliest youth he had studied electricity and magnetism in spite of all opposition, traveling from place to place with his trunks full of galvanic batteries and electrical material, never receiving one word of encouragement, but always looked at askance as one no better than he

ought to be, or reprimanded by ignorant pedagogues for not studying languages, dead in every sense to one who could judge of the relative value of things. This repeated rejection of his manuscript by the leading American journal was the most depressing factor in his life.

About this time, Maxwell's great work on Electricity and Magnetism appeared, and Mr. Rowland recognized there the system of units which he had himself invented, as well as many other of his ideas. He also recognized in the author a master mind of the very highest order. He compared this work with his rejected manuscript and said to himself: "This is the judge I want; I am either a fool, suitable for an asylum only, or my work is good. I shall send my papers to this great man and find out." The paper went, and the kindest of letters from the great Maxwell came back, saying that the *paper was of the highest value, and had been sent to the Philosophical Magazine of London!* This verdict naturally eliminated the "depressing factor" above referred to.

This "paper" appeared promptly and established Mr. Rowland's reputation. It is considered to-day the beginning of the modern exact study of magnetism. It was, perhaps, the main cause of his selection for the chair of Physics in the Johns Hopkins University.

While teaching at Troy, he visited his uncle, who was chaplain at West Point. Here he first met Prof. Gilman, who had just been elected President of the projected Johns Hopkins University. Prof. Rowland had been cordially introduced to Prof. Gilman by Prof. Michie. President Gilman was anxious to secure the best man in both hemispheres for the chair of Physics in the new university, over which he was to preside, and at his suggestion the Board of Trustees of Johns Hopkins University wrote to Clerk Maxwell, Lord Rayleigh, Lord Kelvin (then Sir William Thompson), Baron von Helmholtz, and other European scientists for the name of the ablest physicist known to them. With singular unanimity these foreign specialists replied that the most original thinker in the domain of physics was, in their opinion, an American named Rowland, of the Rensselaer Polytechnic Institute, of Troy, N. Y.! Thus indorsed by Europe and America, the position was offered to Prof. Rowland and accepted. He still holds it.

When this flattering offer was accepted, Johns Hopkins University was not prepared to open its doors to students, and President Gilman suggested that Prof. Rowland should take a year's leave of absence. This suggestion coincided perfectly with Prof. Rowland's plans. He went abroad, and was for a while the guest of the great Maxwell. Now, for the first time, he

was able to converse with one who knew more about his favorite subjects than he did. The wonderful and profound knowledge of Clerk Maxwell, combined with a childish simplicity and the kindliest of natures, made a great impression on Prof. Rowland. He looks back to this visit as one of the most notable events of his life. From England he went to France, thence to Germany, where he entered the laboratory of Baron von Helmholtz. It was here he carried out his research on the magnetic action of electric convection—an idea he had conceived in 1868 while reading Faraday's Researches. He returned to America in 1876, and assumed his duties as Professor of Physics in the Johns Hopkins University.

Prof. Rowland was at this time only twenty-seven years of age, a period at which many of his graduate students now begin the study of physics under his able tutelage. His students are sin-

FIRST CONTINUOUS-CURRENT ARMATURE, MADE BY PROF. ROWLAND IN 1869.

cerely attached to him, and have so profound a respect for his knowledge and ability that many of them emulate his example and gladly spend hours of extra time in testing interesting experiments suggested by his lectures.

During the early years of Prof. Rowland's life in Baltimore he made a new determination of the mechanical equivalent of heat, in which he introduced exact thermometry for the first time. He made a considerable correction in Joule's value. He also discovered that water had a minimum value of its specific heat, a fact unnoticed before. Soon after he made a determination of the unit of electrical resistance, the ohm, which demonstrated the error of the British Association Committee. This experiment he repeated with a Government appropriation as a member of the International Congress for fixing this standard. When this congress met at Paris, in 1884, Prof. Rowland protested against the value there adopted, as it did not agree with his experiment. At the Congress of Electricians, held at the Centennial Exposition at Chicago, in 1893, the International Chamber of Delegates, of which Prof. Rowland was president,

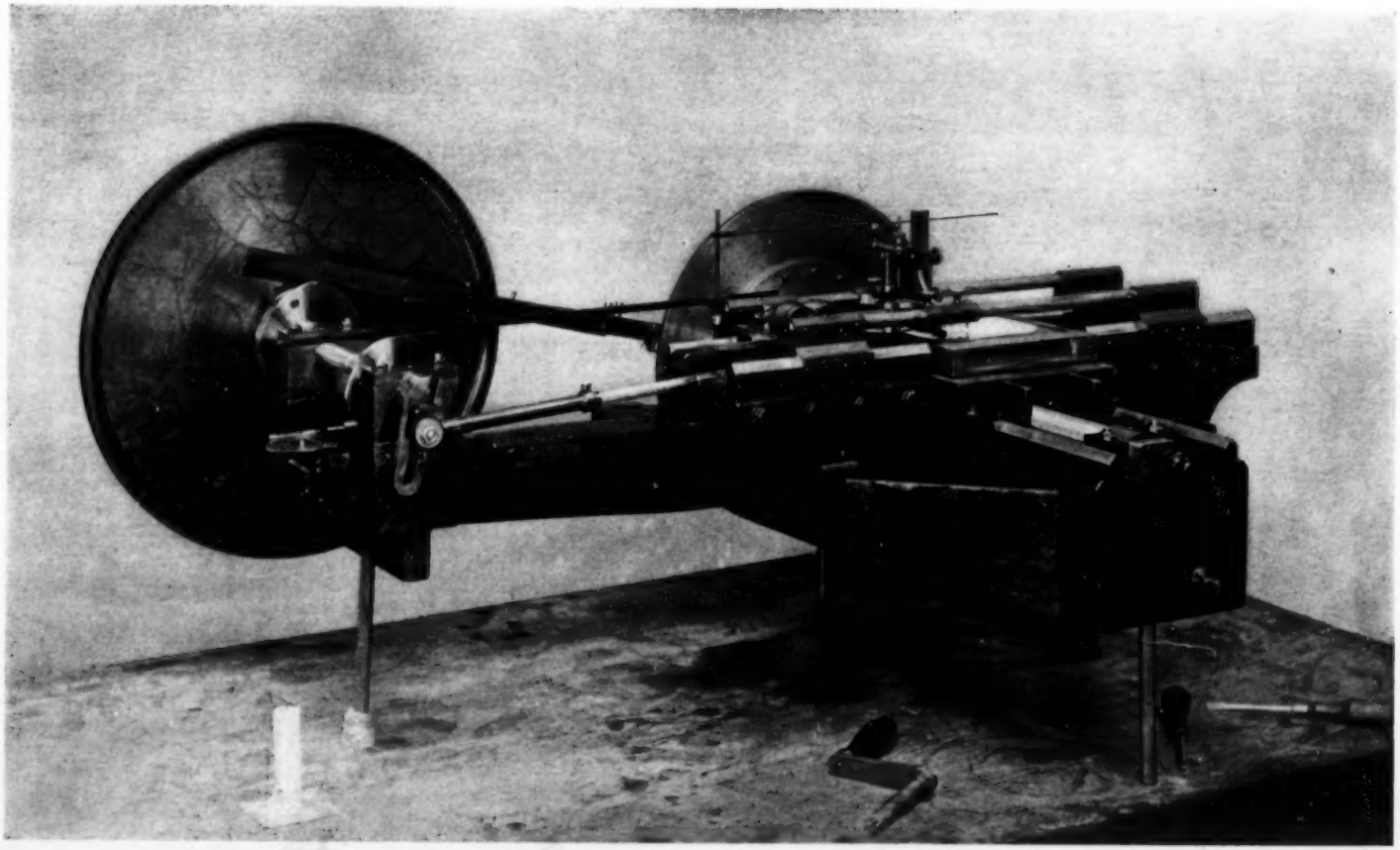
decided unanimously to adopt the value advocated in 1884, and this is now the standard of the civilized world, a triumph of which Prof. Rowland is very proud.

Prof. Rowland's work in physics not only includes that published under his own name, but his influence is felt in the theses of his students who aspire to the degree of Doctor of Philosophy. One of the most notable of these was written by S. H. Hall, and describes a new phenomenon now known as the "Hall effect." The experiment leading to this discovery was described by Prof. Rowland in his lectures, and Mr. Hall was encouraged by his teacher to carry it out to a successful termination. The influence of Prof. Rowland's students in the recent revival of interest in physics, including electricity and magnetism, has been considerable, and the highest position in practical electricity available to an American is held by Dr. Louis Duncan, President of the Society of Electrical Engineers, who is associated with Prof. Rowland and is one of his students.

Prof. Rowland has, with rare exceptions, devoted his time to pure research, and has never endeavored to accumulate a fortune. If he had patented his dynamo, which was finished ten years before Edison applied for a patent, his bank account would be large enough to enable him to perfect any idea he might conceive. Of late years Prof. Rowland has devoted himself principally to the improvement of the apparatus for use in spectrum analysis. He has made three dividing engines for ruling the gratings used, each better than the one before it, and each producing gratings better than those of Mr. Rutherford, hitherto admitted to have been the best. At the present time, all the work of the world in spectroscopy requiring high dispersion is made with "Rowland's gratings."

Prof. Rowland has also invented the concave grating which can be used without lenses, and with which photographic work is best done. These results have been achieved principally by Prof. Rowland's skill as a mechanical designer, and his dividing engines have been constructed not only after his own design, but by processes invented by him and carried out under his own eye. So far nobody has been able even to copy the machines, although the processes have been freely described in his article Screw in the Encyclopædia Britannica.

"Rowland's grating" is made by ruling parallel lines on a concave plate of what is known as speculum metal. This metal is an alloy of two parts copper and one part tin. The parallel grooves are made with a delicately adjusted diamond point. The machine on which the grating was made was manufactured after eighteen months' hard work by Theodore C. Schneider, the machinist at the university (a pupil of George M. Phelps, of Brooklyn), from the



DIVIDING ENGINE FOR RULING GRATINGS (THE SECOND CONSTRUCTED).
The legs are slender and put in loosely in order to prevent the tremors of the earth reaching the working parts.

designs of and by processes invented by Prof. Rowland, who was constantly at hand to direct every movement. This machine is in a dark vault under the laboratory. When a "grating" is being made, it runs night and day. The vault is locked, and no one is allowed to enter it, for the machine is so sensitive that the temperature of a human body would disarrange it. When a new diamond point is being tested, as is now the case, Prof. Rowland will permit a few people to visit it. Sir William Thomson, the Earl of Rosse, Lord Rayleigh, Prof. Ball, Astronomer Royal of Ireland, the late Prof. Helmholtz, of Berlin, Prof. Mascart, of Paris, and Prof. Lemström, of Sweden, are among those to whom this courtesy has been extended. The motive power of the machine is a hydraulic engine. The water is kept at a constant height in a tank near the roof, to insure unvarying speed. It is driven by a belt attached to a solid brass driving wheel on the machine. A crank is turned by the same on the other end of the shaft. This crank moves the carriage that conveys the diamond point back and forth over the surface of the "grating" or plate. This carriage rests on two steel ways, which are flat on top and slanting slightly outward, so that there are three points on one way or rail on which the carriage rests. These "ways" are ground so as to make them as nearly accurate as possible. But they can not be made perfect, for Mr. Rowland tested them with a microscope and found that they were "out"—that is, not exactly perfect—by one fifty-thousandth of an inch. He did not attempt to improve them.

One of the most difficult problems that Prof. Rowland and Mr. Schneider have to solve is to find a diamond point that is exactly right. Some are too blunt, some have one defect, some another, and it generally takes from two to eight months to find an available diamond.

As the diamond carriage moves exactly in the same line backward and forward every time, the metal plate or grating beneath must move slightly when the diamond makes a stroke. These tiny grooves must be exactly the same distance apart, and as there must be from ten thousand to forty-eight thousand parallel grooves or lines made within the space of one inch, it is readily seen that the lateral movement of the metal plate is very small. At every stroke of the diamond, the carriage carrying the plate is moved by means of a steel screw. It is the only absolutely exact screw ever made. The "ways" mentioned above, when tested by the microscope, are one fifty thousandth part of an inch "out" of the exact, but the strongest microscope can find no flaw in the exactness of the screw. In order to manufacture this screw, it was necessary to make it under water, which was kept at a certain temperature. If it had been made in the air, or the tempera-

ture of the water changed, the slight expansion caused by the friction would have made the threads vary slightly. This would have caused the carriage that runs on it to vary slightly, and consequently the spaces between the grooves on the "grating" would vary, and render it useless for scientific purposes. The screw is turned by a solid steel wheel with seven hundred and fifty teeth on the ring, which is moved the space of one tooth at a time by an ingenious contrivance attached to the driving shaft. The screw having twenty threads, the carriage is moved one fifteen-thousandth part of an inch each time, thus making that many grooves to the inch on the metal "grating." The number of grooves may be regulated. "Gratings" have been made with forty-eight thousand grooves to the inch. By the strongest microscope made, the human eye could not see the lines if there were more than a hundred and twenty-five thousand to the inch. Prof. Rowland says he gets the best results from "gratings" with fifteen thousand grooves to the inch. The machine now in use at Johns Hopkins University is the third of the kind made. The first was completed years ago, and is still in use in the vault. The European, and especially the German universities, have tried repeatedly to make a machine of the kind, but have never succeeded. Hence all their best universities get the "gratings" for their spectroscopes from the machine at the Hopkins.

When a "grating" is completed, it is taken out, tested, packed in a handsome hardwood case, and sent to Mr. Brashear in Allegheny, Pa. This gentleman attends to the sale of the valuable "gratings," which cost from twenty to three hundred dollars. The proceeds are divided between Mr. Brashear and the university.

When these tiny grooves, cut with a diamond point on the polished metal plate, are completed and are perfect, the grating breaks up a ray of light into its various colors as a prism does. Some of the gratings produce "ghosts," and are then considered imperfect. Prof. Rowland deals with these "ghosts" of the spectrum in a recent article in the Astro-Physical Journal, of Chicago. He says: "A periodic displacement of one millionth of an inch in a grating will produce visible ghosts which are seen in the second spectrum and are troublesome in the third. With very bright spectra these might even be seen in the first spectrum. An over-exposed photographic plate would readily bring them out."

With the concave grating Prof. Rowland has made an immense photographic map of the solar spectrum, and has determined a system of standard wave lengths which is now universally adopted. He is now having measured the wave length of every line of the solar spectrum and is determining the elements to which they all belong. This is a work of years, as is also the

measurement of the wave lengths of the spectrum lines of all the elements.

These measurements are carried on mostly by assistants, and are paid for by appropriations made from the Rumford fund, the Bruce fund, or the Bache fund. But, at times, money for this work is very scarce. Nothing can come from Johns Hopkins University, as it has lost so much of its endowment that its work is greatly hampered. Thus, Prof. Rowland, in the prime of his life, and at the age of greatest mental activity, finds himself compelled to relinquish carrying out many of his best ideas. He has determined, if possible, to remedy the defect himself. Whether he will be able to do so remains to be seen, but he has never failed to accomplish his purposes, and those who know him best have found that discouragements only spur him to greater effort.

In this connection, however, he remembers one of the most disagreeable incidents of his life. Recently he worked six months for the Cataract Construction Company, of New York, in developing the plans for the transmission of the power of Niagara, in which he overthrew the plans of their engineers and substituted rational ones. He consulted two friends as to the bill he should render for his services. He accepted their advice, as they were admitted to be the most competent judges in such matters. The company sent him a check for one third of the amount, accompanied by an insulting letter! Although abhorring petty disputes about money, his sense of justice was so shocked at this treatment that he immediately brought suit against them, rejecting all offers of compromise. In spite of the fact that the company was backed by half the money power of New York and its best lawyer, a jury of twelve intelligent and impartial gentlemen unanimously pronounced his bill correct and just.

During the course of Prof. Rowland's life he has received many honors, mostly from abroad, where he is probably best known and most thoroughly appreciated. In 1881 he became a chevalier of the Legion of Honor of Paris, and in 1896, at the centennial of the Institute of France, of which he is a corresponding member, he was nominated officer of the Legion of Honor. At the exposition at Paris, in 1890, his gratings and map of the spectrum received a grand prize and gold medal. About 1881 he received the grand prize of the Venice Academy of Sciences for an essay on the Mechanical Equivalent of Heat. In 1884 Prof. Rowland received the Rumford medal from the American Academy of Sciences in Boston for his researches in light and heat. In 1890 the Draper medal was awarded him for his researches in spectroscopy.

He is an associate fellow of the American Academy of Sciences of Boston, and member of the National Academy of Sci-

ences, Washington; honorary member of the Royal Society, of London; one of the twelve honorary members of the London Physical Society; one of the ten honorary members of the Paris Physical Society; honorary member of the Royal Society of Göttingen; of the Accademia dei Lincei, Rome; Academy of Sciences, Catania, Sicily; of the Manchester Literary and Scientific Society; of the Cambridge (England) Philosophical Society; of the Swedish Academy of Sciences, Stockholm, of the Italian Society of Spectroscopists, etc. He is corresponding member of the British Association, of the Institute of France, etc.

In 1883 he presided over the Section of Physics of the American Association for the Advancement of Science at Minneapolis, before which body he delivered an address, A Plea for Pure Science, which was published and read with great interest throughout the world.

He was foremost among the members of the Electrical Congress at Chicago, and was President of the International Chamber of Delegates for the establishment of electrical units. The students of the University of Chicago, who occupied front seats in the Academy of Fine Arts when this body of learned men was called to order, regarded Henry Augustus Rowland as second only to his great teacher, the late Baron von Helmholtz. It is possible that those who were privileged to be present on that occasion will never again see, on a single platform, so many men of international reputations.

In 1880 the Johns Hopkins University conferred on him the degree of Doctor of Philosophy. In 1895 Yale University conferred on him the degree of LL. D.

In 1890 Prof. Rowland was married to Miss Henrietta Harrison, of Baltimore, who is thoroughly interested in his work, and is in perfect sympathy with him. They have two bright and interesting children. His oldest, a little daughter, Harriette, named for his mother, is four years old. His son, Henry Augustus Rowland, though only three years of age, already bids fair to follow in the footsteps of his distinguished father. The lad is very fond of visiting the physical laboratory, and will for a long time watch with silent and absorbed interest the movements of the intricate machinery, which is kept constantly going under the supervision of Mr. Schneider.

Prof. Rowland is a tall, strongly built man, and can frequently be seen at one of the windows in the basement of the physical laboratory of Johns Hopkins University industriously working and deeply absorbed in making investigations and experiments which the vast majority of his fellow-citizens would not comprehend. Every one who approaches him is at once impressed by his genuineness. His favorite exercise is horseback riding. Dur-

ing the winter he rides every day many miles in the country around Baltimore, and sits his horse like a Centaur. He especially enjoys a fox-hunt of the old-fashioned sort, for which Maryland has been famous for a century, the first requisite of which is such perfect horsemanship that seven-rail fences and deep ditches are not considered obstacles to the chase. A "paper chase" he would probably regard with as much contempt as he does the pamphlets in his "crank library," a collection of so-called scientific papers written by people who know nothing of science. He intends to deliver a lecture soon on the contents of this "crank library."

His vacation is usually spent in his native New England. He cruises along the coast in a small yacht of his own design, in whose seagoing capacity he has great confidence. It is said by some of his students, who assume to know more of nautical science than of physics, that this yacht does not "ride the waves" properly, and that some day they expect to hear that their teacher has been drowned in a rough sea off the Atlantic coast. These critics are not aware of the fact that during his boyhood a part of Prof. Rowland's vacations were spent in New York city, and that his favorite pastime was rowing or sailing his own boat in New York harbor. A glance at the shipping in that port, with steamships and sailing vessels coming from and going to all parts of the world, with ferryboats constantly passing from pier to pier, and the shrill whistle of the omnipresent tugboat constantly rising above the roar of commerce, ought to convince the most skeptical that even as a boy he was a seaman who knew his business.

This sketch of Prof. Rowland's life should be read with pride and interest by every one of his fellow-citizens. It should encourage every ambitious and gifted American youth to persevere in an effort to overcome obstacles which prejudice and ignorance often interpose to obstruct the career of those who are born with mental powers too great to be trammeled by ancient traditions or to be made pliant to an uncongenial routine.

THE thumb is regarded by Mr. B. Whitehead as one of the most important factors of civilization. Without it, or with only a rudimentary and imperfect thumb such as the monkeys have, men could never have made or used arms of offense or defense, and would never have been able to exercise a number of industrial arts by means of which they have improved the conditions of their existence. No monkey can throw a harpoon or draw an arrow with any precision, turn a spindle or twist a cord. This importance of the thumb has been observed by primitive peoples. Sir John Lubbock mentions savages in Australia and Africa who are accustomed to cut off the thumbs of dead enemies to disable them from making reprisals upon them.

Correspondence.

PROFESSOR OSTWALD ON THE MECHANICAL THEORY.

Editor Popular Science Monthly:

SIR: In the last number of your valuable publication appeared an address by Prof. W. Ostwald, of Leipsic, on The Failure of Scientific Materialism, the reading of which suggested the following considerations:

Leaving aside the intrinsic value of his statements, I wish to call attention to the sensational manner in which they are announced, and to the implied claims on them as original thoughts, or, indeed, as the author himself says, as indisputable, though startling, scientific *discoveries*. He tells us that the atomo-mechanical theory, which he styles "scientific materialism," has proved an absolute failure; that he proposes to deal it its death-blow, and lay the foundations of a new and truly scientific doctrine—the "energistic theory"; that, whatever effects his discovery may have on the ethical and religious systems of the world, he is under moral obligation to make known what he has found in Nature; that he is like a sailor who, having discerned "breakers ahead," must warn his fellows of the impending danger; that he has "a duty to discharge," and "should consider it wrong if he failed to speak of what he has seen." Further on he says that, although he is not exactly the discoverer of the new truth "which the departing century can offer the dawning one," he is the first one to see that "we have been in possession of the truth for half a century without knowing it."

Without intending any disrespect to Prof. Ostwald, I must say that the body of his article greatly disappoints the expectations naturally aroused by this solemn preface. While we prepare to see it demonstrated that Newton's law of gravitation is a metaphysical superstition; that the human species is doomed to disappear within the next generation, or some other wonderful and awful novelty, we find nothing but very common theories and hypotheses, which, however important and interesting in themselves, are topics with which we have been acquainted for a long time. His main contention is, that we do not know of matter apart from its "properties"; that these properties are nothing but manifestations of energy; and that, therefore, energy is the only reality of which we can speak with certainty, the belief in a "substratum" or "bearer" of this energy not being warranted by observation or experiment. But whatever the validity of these propositions may be, they are certainly as old as Aristotle, have been repeated by Boscovich, Faraday, and others, and adopted as an ultimate truth, as the fundamental principle of all science and philosophy, by Mr. Herbert Spencer; while among metaphysicians it has been a common doctrine that energy, or *resistance*, is the final criterion of reality. (See J. B. Stallo, Concepts and Theories of Modern Physics, second edition, chap. x; Spencer's First Principles, secs. 63, 68, 71, 73, 74, etc.; Mansel's Metaphysics, third edition, pp. 346–348, 328, 329.) And if, pushing these speculations to their logical consequences, we say that nothing is known to us except as a mental impression, or that, in ultimate analysis, the only reality, or at least the only certainty, is our consciousness, or the aggregate of our mental states, and that we have no knowledge of things in themselves, we shall only be repeating the theories of Berkeley, Hume, Tracy, Kant, Bain, Mill, and almost all modern thinkers, as well as of the old Skeptics. (See Bain's Mental Science, book ii, chap. viii: Kant's Pure Reason, "Esthetic"; Tracy, Idéologie, tome iv; Hume's Human Nature, etc. Tracy is one of the ablest expounders of this doctrine. Some of his views are quoted and approved by Bain in Emotions and Will, *fin.*)

We look in vain for any new *facts* in Prof. Ostwald's article; and apart from a few hints, as a passing notice of electrical phenomena, his real *scientific* argument against the mechanical theory is the irreversibility of the phenomenal world, in contrast with the reversibility of the mathematico-mechanical formulas purporting to represent the former (page 595). Without stopping to show that his interpretation of mathematical formulas is entirely inadequate, that there is nothing intrinsically impossible in the reversibility of natural phenomena, and that his argument applies to "energistics" as well as to the mechanical theory, since the mechanical formulas have nothing to do with "matter," but with energy (mass being defined in terms of force—Rankine's Applied Mechanics, sec. 521), I shall again have to say that the professor is here repeating the law of the Dissipation of Energy, deduced by Sir William Thomson from thermodynamical principles; a consequence of said law being a constant loss of the *availability* of energy and a tendency to universal equilibrium. This law has been further generalized by Prof. Delbœuf into "the law of the fixation of force," according to which no force, after being transmuted into another, can restore *itself* to its original form. Here are some of his statements: "Tout changement a pour effet de faire passer la force de l'état transformable à l'état intrans-

formable; il consomme donc de la transformabilité. . . . La fixation d'une force libre n'est autre chose que sa combinaison avec une autre force qui par là aliène comme elle une partie de sa liberté." Although there is a tendency toward equilibrium, equilibrium will never be reached, "parce que la vitesse avec laquelle se fait le nivellement est une fonction directe de la différence même des niveaux." He also insists on the absurdity of a tree retrograding into a seed, an old man into a child, etc. (See Revue philosophique, 1880, 1882.)

Yours very respectfully,

ANTONIO LLANO.

419 ST. NICHOLAS AVENUE, NEW YORK,
March 16, 1890.

Editor's Table.

PATRIOTISM AND MILITARISM.

PATRIOTISM is one of those virtues which have suffered so much from counterfeit and alloy that the word has come to have a very doubtful sound to experienced ears. So seriously, indeed, has it been damaged that one would in general prefer to use some other term to convey whatever respectable meaning it has hitherto covered. To a large section of the community, there is too much reason to fear, patriotism means little else than a vicious hatred of other countries, in so far as they come into any kind of rivalry or competition with our own. It stands for noisy, offensive, and vulgar national self-glorification, for truculence in the discussion of international questions, and a readiness to cast justice to the winds in any transaction with a foreign state. Patriotism of this type commends itself only too readily to boyhood with its as yet undeveloped moral sentiments, and therefore to adopt any special measures for inculcating it on the youthful citizen is, to say the least, most unnecessary. The true view of patriotism embraces none of the elements mentioned. To be a patriot a man does not need to hate or despise foreign nations; he does not need to indulge in vainglorious language, or even in vainglorious thoughts in regard to his own country; nor does he require to cultivate an insensibility to justice in regard to any international dispute in which his country may be engaged. Patriotism in the true sense implies simply such a love for one's country as inclines to disinterested service at all times and under all circumstances — a love which does not need the stimulus of quarrel with a foreign state to call it into activity.

To get a true measure and comprehension of the subject we should compare patriotism with certain other recognized virtues. The father of a family owes love and protection to his family. What should we think, then, of the father who, neglecting or even abusing his family at other times, showed his paternal feeling chiefly in espousing their quarrels, just or unjust, with other families, and greedily embracing every opportunity thus afforded for acts of hostility to his neighbors? We could only say that he was a man of a very low type, whose actions were mainly determined and governed by hatred and malice. Quite in the same way we are entitled to judge the citizen's love for his country, not by the blindness of his partisanship in questions in which his country is involved, nor by the rancor he displays in speaking or writing of foreign states, but by the interest he takes at other times, and at all times, in his coun-

try's welfare, and the service he renders to the cause of good government, and the general amelioration of the social and political life of the nation. We think it will in general be found that the citizen who is earnestly engaged in useful social work, and whose ordinary course of life affords an example worthy of imitation, will not be a patriot of the malignant type. His voice will not be cast for war on trivial occasions, nor will he take a ferocious delight in thinking of the disasters and humiliations which his country could inflict on a foreign foe. The man who truly loves his own country will find it impossible to hate any other. The good father of a family is a man who can be counted on for friendly offices beyond the limits of his family. He enters into the feelings of other fathers, and considers family life in general a sacred thing. So with the man who has a true feeling of devotion to his own country: he learns through it to love humanity at large.

Who, then, is likely to be what we have called the malignant patriot? The spoilsman makes a good one. Living as he does on the corruption of politics, the least he can do is to shout for the flag, and pour contempt on foreigners on every occasion, suitable or unsuitable. If he did not thus protest his love for his native land, people might think he was a parasite or saprophyte pure and simple; but thus he makes an effort, which we may take for what it is worth, to redeem his character. And with the spoilsman we find, vociferous for war and cynically indifferent to justice and humanity, a large body of individuals who, without being spoilsmen in the full political sense, are spoilsmen in a general everyday sense, in that they live by arts more or less inimical to the general welfare. These have no sense of organic union with the community, and the expression of hatred toward other nations affords them an emotional outlet which they could ill spare. Then we have the considerable number of those who, though they may, in their way, be tolerably useful citizens, are persons whose moral and intellectual natures are but poorly developed, and who perhaps sincerely think that hatred of the foreigner is at least a function of love of one's own fellow-citizens. These constitute a class of whom, perhaps, better might be made, but who in the meantime raise their voices very vigorously and inconsiderately for every aggressive foreign policy which mischief-making demagogues may suggest.

If patriotism in the true sense were more common throughout the civilized world, wars would cease, because patriotism would induce those reasonable, humane, and pacific feelings which are wholly opposed to injustice and aggression, whether practiced by individuals or by states. Unfortunately, the type of feeling which is most in evidence to-day is not patriotism, but militarism, a very different thing. The true patriot wishes his country to be in the right and to do the right in all international questions: the devotee of militarism wishes his country to be strong, so that, whether right or wrong, she may be able to impose her will upon others. It is not too much to say that the military spirit is fundamentally inconsistent with a love of justice for its own sake. It is a very tame business for enormous force to be always tied to exact rules of right; the temptation is almost overwhelmingly strong to blow right some fine day from the mouth of an eight-inch gun, and so set the war fiends dancing. The nation that sets out to have enormous armaments does not

thereby intimate to the world, nor yet to its own citizens, its desire and intention to be always in the right, to pursue undeviatingly the path of justice, but a desire and intention to be able to pursue whatever course may be indicated by national ambition. No one can doubt that in our own country the disposition to trust to right in our dealings with other nations has been growing feebler just as our armaments have been growing stronger. Every new battleship makes it a matter of less account—in the eyes of a large part of the nation at least—that we should be in the right at all. By and by, if things advance much further in the same direction, national honor will be held to demand that we commit some great wrong, and prove at the cannon's mouth that we are able to stand by it.

We confess that this is not what we were hoping for. Some twenty or twenty-five years ago, when the minds of our people seemed turning in the direction of a sound philosophy, we were very far from anticipating that at this date there would be a recrudescence of the spirit which derides philosophy and enthrones brute force in its place. We feel like asking what our schools and universities have been doing all this time. Have they been teaching our youth that, in the matter of citizenship, the highest honor any man can enjoy is to belong to a state whose respect for itself binds it to respect for others, and whose aim is far more to show the possibilities of civilized life at home than to make an imposing display of strength abroad? Do they teach that, if a nation can, without sacrifice of honor or betrayal of the just interests of its citizens, live at peace with all the world, it is its bounden duty, both for its own sake and as an example to mankind, to do so? Do they teach that war and liberty are essentially antagonistic, and that, only by parting with a large share of domestic liberty, can any nation take its place among the great fighting powers of the world? We fear that, whatever has been done in the way of inculcating these truths, the instruction has been far from adequate. At the same time it is satisfactory to note that, so far as men of scholarship and learning have spoken in the recent discussions of international questions, their voices have almost uniformly been raised on behalf of wide, humane, and reasonable views of national policy.

It was with special pleasure that we noted not long ago a "Symposium on Patriotism in the Public Schools" in the Interstate School Review, of Chicago, in which some excellent sentiments were expressed. One writer, U. J. Hoffman, says: "Let children study the lives of patriots, let them read the thoughts of patriots, such as Hawthorne, Bryant, Longfellow, and love of our native land will take care of itself. The requirement of the flag law, that the flag shall float every day, has caused the purpose of the law to be defeated." Another, William D. Kelley, says most excellently: "In our selection of subjects for hero worship we need not choose war heroes rather than those who are eminent in the acts of peace and charity. The man who stands up resolutely in the common council or the town meeting for what is right and against what is corrupt and wrong, is a patriot, and often a hero, and may be made as truly an example for children as those far removed from them in time, and whose fame is national or world-wide. The teacher should show that governments can commit sins as well as individuals. I would teach a love for the Revolutionary principles and a dislike for our

country's attitude in the Mexican War." A third writer, A. Califf, says: "I believe in teaching patriotism, but I do not believe in trying to legislate patriotism into people. I consider the 'flag law' a total failure, so far as the teaching of patriotism is concerned." A fourth, M. W. Marvin, gets to the root of the matter in the observation that "the teaching which tends to develop properly the pupil's sense of right and wrong, of humanity and justice, that which makes him better acquainted with his duty to himself, his neighbor, and his country, better prepares him for the future duties of a patriotic citizen."

If the teaching given in our schools and other educational institutions on the subject of patriotism were all on these lines, there would be nothing to complain of; on the contrary, there would be much cause for congratulation, and much reason to hope for good results at no distant day. Unfortunately, what with flag laws and other nonsense, it is difficult for the schools in some of our States not to be made subservient to the spirit and aims of militarism; and if the mind of youth is thus perverted, what will the harvest be? These are times when well-disposed citizens should take earnest and frequent counsel together as to the best means to antagonize the hurtful influences that are abroad, and to uphold the ideal of peaceful civilization as the true goal of national progress.

THE RÖNTGEN RAY.

PROF. RÖNTGEN'S discovery of the X ray crowns two as alluring courses of investigation as ever called forth the resources of experimental skill. One of the pillars from which sprang the achievement of the Bavarian teacher rose from the observation by an Italian cobbler, Vincenzo Cascariolo, who three hundred years ago picked up near Bologna a bit of sulphate of barium. It might, he hoped, have some value in alchemy, for it glowed in the dark as if with sunshine it had stored by day. This singular property of phosphorescence has since been noted in a wide diversity of minerals, in nasturtium and other blossoms, in fungi and decayed wood, in a host of flying and creeping things of kin to the common firefly and glow-worm. As means of detection are refined, it becomes more and more probable that phosphorescence, while highly characteristic of but a few substances, really manifests itself in matter of all kinds. In this it may share the universality of many other properties.

And phosphorescence, half a century ago, was discovered in direct alliance with other curious qualities. Of high importance was the discovery, in which Prof. Stokes took an honored part, that rays which enter the eye only to prove it blind can be brought within the compass of vision if suitably modified; that when ultra-violet rays of the spectrum traverse solutions of sulphate of quinine and other compounds, or take their way through uranium glass, they are so reduced in refrangibility as to fall within the range of perception. The light thus indirectly brought to view is fluorescence, the continuous phase of what in brief and fitful gleams is phosphorescence. Among the compounds fluorescent in an eminent degree is the platinocyanide of that same barium whose sulphate aroused the wonder of the Bologna cobbler.

While one group of explorers was running down the facts of phosphorescence and fluorescence, another group was examining the behavior of attenuated gases when excited by electricity of high tension. The familiar tubes of Geissler now shone with a radiance resembling the au-

rora of the northern sky. After Geissler came Prof. Crookes, and other physicists, who varied their queries in many ingenious ways. They replaced air with other gases, they brought exhaustion to a close approach to perfection, they changed the forms of tubes, the material of the electrode or current carriers, they increased and diminished the intensity of the electric discharge. Most significant of all, they placed fluorescent substances in the tubes, and brought them to vivid radiance.

Now came the epoch-making experiments of Hertz, which demonstrated Maxwell's theory that light is an electro-magnetic phenomenon; that light and electricity move through the same medium and at the same rate. Incidentally, Hertz produced electric waves of new amplitudes, which readily took their way through wooden doors and stone walls. In his vacuum tubes, by their capacity to excite fluorescence, he found that cathode rays penetrated thin sheets of gold, copper, aluminum, and other metals, while, strange to say, they were arrested by the glass of the tube itself. Hertz had abundant reason to think that, given a concordant ray, any substance whatever offers it a free and open path. His researches, cut short by his lamented death, were continued by his assistant, Prof. Paul Lenard, who inserted in the wall of a vacuum tube a tiny window of aluminum. Through this window he succeeded in bringing a cathode ray into the outer air for a distance of some three inches. This ray had all the characteristic tokens of light; it was capable of reflection, refraction, and polarization; it excited fluorescence; it had photographic power.

At this point Prof. Röntgen comes upon the scene, repeats the experiments of Prof. Lenard, and, by such a stroke of good fortune as befalls only the man who earns it, he incloses an excited vacuum tube in blackened cardboard treated with barium platinocyanide. To his delight he discovers that the cathode beam is accompanied by a radiance hitherto unknown, which, although of fluorescent and photographic quality, can scarcely be any form of light. It is not susceptible of refraction or polarization; indeed, it seems as if it might be a stream of infinitesimal particles, since its path is less impeded in a light metal, aluminum, than in a dense one, such as platinum.

Thus culminate the experiments of two companies of students—those devoted to inquiry regarding phosphorescence, and fluorescence and those who investigated the conduct of attenuated gases excited by electricity in vacua. It was many a weary day before the explorers came within sight of each other, before they could join hands on the common ground where all research meets at last in Nature's fundamental unity. At every step but the final one, the observer intent solely on "results" might well have asked, "What's the good?" And yet results of profound import to science and art lay bound up in quests not to be suspected of the most averted wooing of utility. The eye and its wonderful supplement, the photographic plate, now find disclosed what had been deemed forever hidden from sight and light. The physician and the surgeon rejoice in new powers of relieving pain and saving life. The physicist enlarges his conceptions of both matter and energy; he explores by a new path the mazes of molecular structure and motion. Once more it is emphasized that Truth is won only by her disinterested lovers, who, nevertheless, ever find her dowered with wealth greater than fortune-hunter ever dared pursue.

In practical applications of the Röntgen ray America is taking a leading part. But is it to her credit that here, as in so many other cases, she should be willing to have the pioneer work of science performed abroad? Do the planters and waterers of American universities fully realize that if there is to be applied science there must first of all be science to apply, that original research has the first claim upon their regard? "There is that scattereth and yet increaseth; and there is that withholdeth more than is meet, but it tendeth to poverty."

REGENERATION AND SCIENTIFIC ETHICS.

NORDAU has been answered. An anonymous author has done it in a book entitled Regeneration.* This champion declares pretty nearly everything sound which Nordau finds degenerate, and charges Nordau himself with German, philistine, and irreligious bias, though conceding "value as telling factors in the development of our race" to him and his work. With this critic's discussion of literary and artistic matters we will not concern ourselves; but he has one chapter, or, more accurately, a chapter heading, which we hope will not be taken too seriously. This is The Bankruptcy of Science. The charge that science is bankrupt—that it has not redeemed its promises—arose with the French symbolists. In his examination of these writers Nordau repels the charge, and cites a considerable list of scientific achievements as evidence of the solvency of science. Our author does not find this conclusive; for, he says: "The promises which the symbolists refer to as being dishonored by science are not of the kind that could possibly be redeemed by the achievements referred to in Nordau's splendid list. They allude to promises not really made by science, but by rash and prejudiced scientists." In other words, these promises are forgeries, and any one who would call science bankrupt because of its inability to redeem all the forgeries made in its name must be degenerate indeed. The fact that such fraudulent promises have been made and accepted, and of sufficient numbers and face value to attract attention, is really as impressive a testimony to the high standing of science as anything that Dr. Nordau has advanced in its behalf. No knave is ever fool enough to forge large drafts upon a concern that has not proved its ability to meet heavy obligations.

Our author next tells what these unauthorized promises were—that science was to furnish substitutes for religion and morality and to lead the human race into an ideal mode of life—and goes on through a dozen pages charging evil consequences to their nonfulfillment, and denouncing the scientists who made them. Although he says all this under the heading The Bankruptcy of Science, he is careful everywhere not to charge the dishonored promises in question to science itself, but to the "rash and prejudiced scientists," before mentioned, with whom he declares Nordau to be in sympathy. Our author's aggressive chapter heading is, therefore, merely a convenient phrase borrowed from the symbolists, and he is guilty of a petty deceit in using it without quotation marks or other qualification over pages which do not prove nor even charge bankruptcy against science itself.

In discussing the promises of the "rash and prejudiced scientists,"

* London: Archibald Constable & Co.; New York: G. P. Putnam's Sons.

which he does at length and with much vigor, our author shows that he can not or will not understand the ethics which the scientists are developing. He says: "As to morality, the religion of humanity seemed extremely untrustworthy; for the removal of all personal responsibility, and the certainty of complete annihilation after death, seemed to give the strong-minded and clever people the strongest possible inducement to make their fellow-beings tools for their own happiness." Going on, he draws a dreadful picture of the effect which the ethics of the scientists has produced upon ordinary mortals who, "caring little for what would happen to the next generation, or still less to generations thousands of years hence," have lived for self-gratification. He returns to this subject in a later chapter and instances "the case of a poor laborer who, in the usual course, will work and suffer during his whole life and die in poverty. To escape such a destiny," says our author, "many roads are open to him if he have courage, exceptional ability, and no belief in a hereafter. . . . He might even avoid violent and vulgar crimes and operate in a safer manner. He might blackmail a rich man. . . . He might turn first a usurer, then a financier. He might keep a degrading public house or a gigantic immoral place of amusement. He might issue a debasing newspaper, write corrupting books and dramatic pieces." A careful revision of his manuscript or a sense of humor, such as he denies to Max Nordau, ought to have shown our author that he has here created an impossible character. A "poor laborer" with the "courage" and "exceptional ability" to do any one of these things, would not "in the usual course work and suffer during his whole life and die in poverty." He could secure ease and a competency in many an entirely moral calling.

We feel well enough acquainted with the ethics of the scientists which our author denounces to say that one of its cardinal principles is the inevitable sequence of cause and effect. From this law it follows that no one can do evil without evil being returned. Circumstances may postpone the effects of his acts until after his death, but he can never count on this, and every one sees cases in which the reaction is swift and terrible. Even if he were sure that the consequences of his evil deeds would be borne mainly or wholly by the next generation, there would still be a restraining influence upon him. How can a more agonizing punishment be inflicted upon a mother than through her children, or a stronger appeal be addressed to her than one for their welfare? And it is a question whether the love of a father for his offspring is not as strong as that of a mother, even if less intense. But aside from ties of blood we do care for those who are to survive or come after us. The conduct and labors of many a person have been avowedly governed by the desire that men should speak well of him after his death. Countless lives have been heroically sacrificed through devotion to fellow-creatures or native land, perhaps mingled with a wild delight in conquering obstacles, but without thought of reward hereafter.

The central idea of the ethics of the scientists, as we understand it, is conformity to the order of the universe. Any one who violates this order in his relations to his fellowmen is just as sure of provoking a punitive reaction as when he comes in conflict with the law of gravitation. This truth would be more evident if scientific ethics were more generally taken as a guide. The

only reason why the man whom our author supposes as preying upon his fellows can be presumed to succeed at all in his career is that he would be alone in a community which had a different moral code. If we suppose him to be surrounded by men like himself, as many depredations would be committed upon him as he committed upon others, and he would quickly abandon his policy as unprofitable. To accept the dictum that nothing but a belief in reward or punishment after death can keep a man from taking every possible advantage of his fellows is to put human beings lower than the beasts. It is not a hope of immortal happiness that causes ants of the same colony or bees of the same swarm to be just, considerate, and even generous toward one another, that constrains the old males of herbivorous quadrupeds to stand guard over the rest of the herd, or that makes it practicable for certain carnivores to hunt in packs. Experience, individual or inherited, has given them a controlling sense of what conduct pays best in the long run. Those creatures which do not co-operate in communities are yet far from trespassing upon others of the same species in the manner of our author's "poor laborer." If the beasts can perceive so much of the order of the universe as to keep their conduct from becoming unduly egoistic, is not man capable of learning the same lesson? The ethics of the scientists is far from being such an empty husk as our author represents. It is imperfect, to be sure, but can a complete solution of so great a problem be expected in a few short years? Moreover, some allowance for any partial failure that may be observed in its application should be made on account of the frailty of human nature and the disturbing influence of unsympathetic associates.

Nordau being one of the scientists who upholds the new ethical theory must, his critic thinks, have a bias against the adherents of revealed religion. The critic claims to find evidence of such a bias in Nordau's book, and a large part of his criticism is based upon this claim. Regeneration is largely an effort to impeach the fairness of Nordau's judgment, and to discredit his diagnosis by an appeal to religious prejudice. As such it should be estimated.

Scientific Literature.

SPECIAL BOOKS.

Dr. *A. F. Chamberlain* has chosen for a folklore study a field made doubly attractive by the newly aroused interest in the psychology of the child.* Truly he has garnered an abundant harvest. It would be difficult to think of any activity or relation of children that is not represented in the thirty-three chapters in which he has arranged his material. From the cry that it utters and the more or less ceremonial care that it receives on its entrance into the world up to its admission to the society of adults, each phase of childish thought or action and of parental care has its wealth of customs and sayings. Thus Dr. Chamberlain tells us, on the authority of

* The Child and Childhood in Folk-thought. By Alexander Francis Chamberlain. Pp. 464, 8vo. London and New York: Macmillan & Co. Price, $3.

Boas, that Songish and Nootka Indian mothers press and rub certain parts of the newborn infant's body in order to give it the shape that they deem beautiful. Many are the modes of expressing affection for children among different peoples, but it seems strange to find under this head the custom of burying a live infant with the mother who has died in giving it birth, for the practice often has an element of vindictiveness. There is a considerable mythology connected with childhood, including lore about guardian spirits and bogeys, also the myths made to answer children's questions as to where the latest addition to the family came from. The folklore connecting children with plants and with animals is an especially delightful branch of the subject. The firstborn child becomes a social factor among some peoples the moment it sees the light, for its birth changes the status of its parents in the community. Its rights of heritage, etc., and the marriage that is contracted for it in its early years among some peoples—even in England in the sixteenth century—are other features of its social importance. At school and in the societies, secret or open, which they form among themselves, including the street gangs of large cities, children reveal the traits that are brought out only by close association with one's equals. The efforts of the child in learning and making language, and as an actor, inventor, poet, musician, and judge, afford an instructive insight into his mind, while his elevation to the position of oracle, weather-maker, healer, priest, hero, and deity shows us the adult mind of many primitive peoples. This volume is not absolutely restricted to lore in which the child is the central figure; thus three of the early chapters are devoted to motherhood and fatherhood, while legends about the origin of certain peoples and the admission of women to the priesthood among others have no obvious connection with childhood. The author gives us a bibliography of five hundred and forty-nine titles, and, with few exceptions, his lore and legends are referred to this list by volume and page. One of the evils attending the great benefits that have been derived by Americans from the study of German authorities is the practice of dividing indexes that is beginning to creep into American books. In this respect Dr. Chamberlain out-Germans the Germans. His collection of child-lore proverbs (which is a feature of the book worthy of special mention) has two indexes—one of the peoples, the other of the authors, from which they are drawn; his bibliography, which follows these, is divided into three classes, each arranged in a separate alphabet by authors, and each followed by an independent subject index; then comes the general index to the volume, the entries of which are divided into three classes, each arranged in its own alphabet. Obviously the user must spend more time in getting at the right subdivision of such lists than in finding his reference. But in spite of this systematic confusion at the end there is not a dry page in the book nor one without scientific value.

The art of depicting the successive positions passed through by animals and other bodies in motion, which aroused much public interest a few years ago, has not been allowed to stand still since that time. Great advances in processes and execution have been made and more difficult problems have been solved, so that the results which M. *Marey* is now able to present to the public are remarkable for their range and definiteness.* The camera

* Movement. By E. J. Marey. International Scientific Series, No. 73. Pp. 323, 12mo. London: William Heineman. Price, 7*s.* 6*d.* New York: D. Appleton & Co. Price, $1.75.

used by him for chronophotography, as he calls this art, has for its chief peculiarity two circular diaphragms behind the object glass which revolve in opposite directions. There are openings in these disks, and when two of them come opposite the lens there is a momentary exposure of the photographic plate. With suitable accessories, including a specially constructed tank, the same apparatus is used for photographing the movements of aquatic creatures and the motion of waves. When it is desired to take a large number of images per second the apparatus must be modified so as to use a moving film instead of a fixed plate, and for photographing free birds and some other objects whose motion can not be controlled, the photographic gun is employed with the film. In the volume before us the author describes the results he has obtained with these forms of apparatus in recording the movements of man, the horse, birds, fish, starfish, jellyfish, reptiles, the crawling and flying of insects, the squirm of the eel, and the pollywog's wiggle. The methods that have been devised for meeting special difficulties are remarkably ingenious. Thus, when the movements of a running man are to be pictured at such short intervals that the successive images would be partly superposed and hence give a confused picture, the subject is dressed in black with white marks on the head, arm, and leg. The result, which consists of images of these marks only, suggests the march of a file of skeletons at the double quick, and can be very readily studied. After the same manner the trajectory of an insect's wing is sometimes made visible by gilding its tip, or that of a crow's wing by affixing a bit of white paper to the end of one of the feathers. Chronophotography has also been applied to experimental physiology, and M. Marey gives us a series of pictures representing the movements of the heart of a tortoise under artificial circulation. Moreover, movements visible only under the microscope can be pictured by this process, but only a beginning has been made in the latter field. The volume appears in the familiar form of the International Series, and is illustrated with over two hundred figures.

One who would know the birds of Britain can hardly do better than allow himself to be introduced to them by Mr. *Hudson*.* This author writes for the general reader and the amateur rather than the ornithologist; hence he gives the coloring and size of each species in from three to six lines, and follows this with a popular description of its feeding and nesting, habits, song, etc. He describes all the species that reside permanently, or for a portion of each year, within the limits of the British Islands, and takes pains to distinguish from these the occasional visitors and the stragglers, to which he gives only brief mention. In his descriptions, especially of song, he frequently quotes John Burroughs, with whom he generally finds himself in agreement. But though the book is untechnical, let no one suppose that it is unscientific. The species are grouped by orders, and follow the arrangement of the British Ornithologists' Union. There is also a chapter on the structure and classification of birds, by Frank E. Beddard. The illustrations of the volume deserve especial mention. There are, first, eight colored plates, from original drawings by A. Thorburn, representing the golden eagle, bearded titmouse, goldfinch, bittern, common teal, ptarmi-

* British Birds. By W. H. Hudson. Pp. 363, crown 8vo. London and New York: Longmans Green & Co. Price, 12*s.* 6*d.*, $3.50.

gan, dotterel, and roseate tern; there are also eight plates and one hundred figures in black and white from original drawings, by G. E. Lodge, and three illustrations from photographs from Nature by R. B. Lodge. The execution of both illustrations and letterpress is excellent. It is perhaps too much to expect immaculate diction as well as scientific accuracy and a pleasing style in the same writer, but it does seem that a second thought would have prevented Mr. Hudson from saying, "The food of the cuckoo is exclusively insectivorous."

GENERAL NOTICES.

Dr. *Ostwald* has again laid the chemists of the world under obligations to him by a helpful discussion of the principles underlying a department of their science.* Feeling that the scientific side of analytical chemistry had been left too far behind by the technique of the subject, he has undertaken to make available recent advances in chemical theory that are capable of throwing much light upon the processes of the analytical laboratory. The author points out that for the recognition of a substance only a few of its properties need be ascertained, for if the substance under examination agrees perfectly in some of its properties with a known substance, it will agree in all. It usually happens that we have a mixture of substances to examine, and the separation of these must precede their recognition. He next shows that separation is a mechanical operation and usually depends on transforming one substance after another into a different state of aggregation from the rest of a mixture. Chemical separation consists in such transformations, and is hence really a preparation for mechanical separation. In treating these processes the author discusses the theory of solution, an important law of which is that salts do not exist as such in aqueous solution, but are dissociated more or less completely into their constituents or ions. Other laws concerned in chemical separation are those of chemical equilibrium, the course of chemical reactions, precipitation, and those governing reactions attended with the liberation or absorption of gas and reactions accompanying the extraction of a dissolved substance from one solvent by means of another. To this chapter the author has added a section on electrolytic separation. Dr. Ostwald touches upon the measurement of the quantity of a substance that has been separated and recognized, or quantitative analysis, and then passes to the application of the laws just enunciated. This part of the work is arranged according to the usual analytic groups, and the behavior with reference to their ionic state of the substances treated is made especially prominent. The author holds that "if we adhere constantly to the point of view that analytical reactions are with very few exceptions *reactions of ions*, then a review of the facts of analytical chemistry becomes at once infinitely simpler."

One of the latest additions to the Library of Useful Stories is a popular sketch of geology.* The author first calls attention to the earth's internal heat and to its effects in producing the rocks of mountains and volcanoes. He then shows how the materials of stratified rocks are produced and laid down and what a variety of fossil vegetable and animal forms are included in them. This brings him to the descriptions of the successive geological formations, from the Archæan to the gravels, which occupy the rest of the volume. The aim of the author has been "to tell the story of the Earth so that its past history helps to explain its present condition." To this end he constantly points out how familiar appearances result from the processes which he is describing, and he also draws especial attention to the information which fossils give us con-

* The Scientific Foundations of Analytical Chemistry. By Wilhelm Ostwald. Pp. 207, 12mo. London and New York: Macmillan & Co. Price, 5*s.* net, $1.60.

* The Story of the Earth in Past Ages. By H. G. Seeley, F. R. S. Pp. 186, 24mo. London: George Newnes, Ltd. Price, 1*s.* New York: D. Appleton & Co. Price, 40 cents.

cerning the rocks in which they are found. The text is illustrated with forty cuts.

The inscription on the back of a volume before us is a most unfortunate one,* for if the student does not take the trouble to look between the covers he is led to believe that the book is an extensive monograph on *Peripatus*, with forms closely related to this extraordinary animal. If he passes it in consequence of this misleading title, he will have missed an exceedingly condensed and clear account of the external features, habits, and anatomy of *Peripatus* by Mr. Sedgwick, filling twenty-six pages; a most valuable chapter of fifty pages on the *Myriapoda*, by F. G. Sinclair; and another chapter on the orders *Aptera*, *Orthoptera*, *Neuroptera*, and *Hymenoptera*, by David Sharp, of five hundred pages! As the other orders of *Insecta* are to be dealt with in Volume VI of this series, one wonders what the lettering on the back of Volume VI will be—possibly *Peripatus*, etc., by Sedgwick, see Volume V, or, as it will begin with the *Coleoptera*, some low and aberrant form will be selected, and on the back the comprehensive title *Stylops*, etc., will stand for the great orders *Coleoptera*, *Lepidoptera*, *Diptera*, and *Hemiptera!* With this criticism, we can only say that the book upholds the reputation already established for the series. The illustrations are many and beautiful, the descriptions and grouping of the material clear, and the work an indispensable one to the general student of this great class of animals.

In two text-books on zoölogy recently received provision is made for two modes of instruction. In the one† the scientific method of acquiring knowledge of natural history—through field study and laboratory work—is consistently carried out. A comparatively small number of typical forms (thirty-two), ranging from the amœba to the rabbit, are chosen for study, all being such as may be easily obtained at inland points as well as near the sea. The chapter on insects shows the method of the book. It begins with directions for collecting specimens. The sulphur butterfly is the first species to be studied, and enough of its characteristics are given to enable the student to recognize it. He is directed to collect specimens for study, and while collecting to observe such things as the kind of flowers on which they are found feeding, whether they feed on the wing or not, the organ used in obtaining food, its position when in use and when not in use, its shape and length. Other observations are to be made on a specimen liberated indoors before a closed window. The study is continued with dead specimens. At the end of the chapter on insects is a general account of the life process in this group of creatures. This is followed by a review exercise which involves considerable observation, and after this a lesson in classification is given. An appendix contains lists of books and reagents, full directions for obtaining and preparing material for study, a glossary, etc. There are one or more illustrations for each species studied.

Recognizing the fact that in many large schools, especially in cities, it is impossible to secure provision for either laboratory work or field excursions by classes, Miss *Burnet* has aimed to provide as good a substitute as may be in book form.* Not being limited to animals everywhere procurable, she ranges through the whole kingdom from amœba to man, and gives brief descriptions of a large number of species, including many salt-water dwellers. Independent collecting by the pupil is encouraged to supply the deficiencies of text-book study, directions for taking specimens and preparing them for the cabinet being given in some detail. There are one hundred and ninety-seven illustrations.

The author of this book,† to whom the original structure of the universe has long been a favorite subject of study, has here presented a modified form of the nebular theory of Laplace, based on certain calculations and new ideas of his own. As a starting point, he suggests the possibility of a more attenuated form of matter than we

* The Cambridge Natural History. Vol. V. Peripatus, etc. Sedgwick. Macmillan & Co.

† Elementary Lessons in Zoölogy. By James G. Needham. Pp. 302, 12mo. New York: American Book Co. Price, 90 cents.

* Zoölogy for High Schools and Academies. By Margaretta Burnet. Pp. 216, 12mo. New York: American Book Co. Price, 75 cents.

† Notes on the Nebular Theory. By William Ford Stanley. Pp. 259, 8vo. London: Kegan Paul, Trench, Trübner & Co. Price, 9s.

conceive as nebula, consisting of particles smaller than the chemical atoms, and to this he gives the name "pneuma." He supposes the pneuma to consist not of a single nor a few elements, but of a much larger number than we now know—possibly exceeding ten thousand. He then goes on to describe how these particles might combine to form atoms and how an immense pneuma might condense to form a core around which revolved masses formed from rings that had been detached as the process advanced. In this, and in accounting for the rotation of the several members of such a system, he is not greatly at variance with current theories. His view of comets makes them quite regular members of a planetary system. In the more particular examination of the history and present condition of the earth, which follows, he suggests the possibility of some continental elevations being formed by the projection of cold planetoids upon the molten globe. The probable effect upon the condensing earth of the formation of the inferior planets is then discussed, and, in conclusion, an effort is made to correlate the geological periods, including the Glacial epoch, with astronomical phenomena. The author has read papers upon some of the topics discussed in this book before various learned societies in England. The volume is illustrated with several plates and small cuts.

Food Products of the World is the title of an interesting volume by *M. E. Green*, M. D. (Chicago, The Hotel World). The original intention of the author, who was one of the judges of food products at the Columbian Exposition in 1893, was simply to give an account of the foods there exhibited; but as the work progressed it was deemed desirable to expand the treatment somewhat and make a popular treatise, which should in a fairly thorough manner cover the whole subject. Each food stuff is first treated in a general way. Its history, preparation, cooking, and keeping qualities; its habitat, if animal or vegetable; and, finally, the chemical composition and dietetic value, are given.

Since the appearance of the first edition of this work, *Sedgwick and Wilson's Introduction to General Biology* (Holt, $1.75), in 1886, the original intention of the authors, to publish a second volume which was to form the main body of the work, and to include the study of a series of type forms, has been abandoned. The present volume, in consequence of this, differs in several particulars from the first edition. The introduction has been extended so as to include representatives of the unicellular organisms, *amœba, infusoria, protococcus, yeasts, bacteria.* The study of the animal is placed before that of the plant, and the laboratory directions, which occur in the first edition, having been found unsuitable, are omitted. The general subject matter has been revised and many additions made, especially on the physiological side.

We are convinced from an examination of the text-book on *Organic Chemistry: the Fatty Compounds*, by *R. Lloyd Whiteley* (Longmans, 3*s.* 6*d.*—$1), that its author possesses a high degree of the teaching faculty. He seems to build up a knowledge of the carbon compounds in the student's mind by starting with a few general ideas and adding others in the order and manner in which they can be best assimilated. He is careful also to distinguish what is demonstrable experimentally from what is obtained by reasoning or is assumed as a means of expressing empirical results. He is concise, too, managing to describe in a small volume the fatty hydrocarbons, haloid paraffins, monohydric alcohols and their several classes of derivatives, the cyanogen and carbonic-acid derivatives, the derivatives of unsaturated hydrocarbons, and the dihydric and polyhydric alcohols and their derivatives. Processes for the preparation of a large number of compounds are given, a distinguishing mark being placed against those most suitable for students' work. Commercial processes for producing the most important substances are outlined. There are forty-five cuts, nearly all of laboratory apparatus.

In *Essentials of Vegetable Pharmacognosy* the gross structure of plants is set forth by *Henry H. Rusby*, M. D., and their minute structure by *Smith E. Jelliffe*, M. D. (Haynes, New York). The former monograph begins with the structure of the flower, and passes on to its functions and the production of fruit. The root, stem, and leaf are then considered in succession, after which phyllotaxy and anthotaxy are discussed. The treat-

ment is full but condensed, and no effort has been made to avoid technical terms. The second portion of the work is prefaced by descriptions of various simple magnifiers and of the compound microscope. The structure and contents of the plant cell are then described, after which the tissues, grouped according to function, receive attention. The volume is designed mainly for students of pharmacy and medicine, and both parts are fully illustrated.

The *Bulletin of the Department of Labor*, a bimonthly publication authorized by the United States Congress, began with a number for November, 1895. The Bulletin is designed to present results of investigations by the department of less magnitude than those usually embodied in the annual or special reports, also digests of foreign and State labor reports, new State and national laws relating to labor, and brief items of interest. The first number contains a record of strikes and lockouts in the United States and other countries in recent years, a statement of private and public debt in the United States, a digest of recent reports of State labor bureaus, statistics of employment of women and girls in England and Wales, and a statement of the legal relations between employer and employee.

The Third Series of *Essays by Lady Cook on Social Topics* (Universal Publishing Co., London, 6*d.*) consists of thirteen essays pointing out the need of reforms in the relations between the sexes. In these papers Lady Cook advocates nothing unreasonable, while her mode of presentation is forcible, serious, and free from prolixity.

In two pamphlets—*Discussions on the Gypsies* and *Social Emancipation of the Gypsies*—an effort is made by *James Simson* to obtain better social recognition for this people and to prove that John Bunyan was one of their number (The Author, 43 Exchange Place, New York; 70 cents and 30 cents). Unfortunately, the author has neither the faculty for investigation nor the art of presenting a subject in proportion to his interest in the matters that he discusses.

The Report of the State Geological Survey of New Jersey for 1894 represents work in surface geology in both the northern and southern parts of the State. The areal work in the glaciated area was completed, and good progress was made in the region farther south, especially in the western part of the State—Mercer, Burlington, and Monmouth Counties. These areas were studied in much detail. A map accompanying the report—Geological Map of the Valley of the Passaic—indicates the extent of the work which has virtually been accomplished. It presents an instructive view of the geological features, streams, and towns. Further light is thrown by the results recorded concerning the considerable influence of stagnant ice upon the deposition of the stratified drift of the valleys of the northern part of the State, and the general position already taken concerning the history of the yellow gravel formations. Many facts of great interest are given concerning the artesian wells of southern New Jersey and the forestry of the State, to which the second and third parts of the report are devoted.

The *Revista della Beneficenza Pubblica delle Istituzioni di Providenza e di Igiene Sociale* (Review of State Philanthropic and Provident Institutions and of Social Welfare), Bologna and Rome, *Avvocate G. Scotti*, director, was started with the beginning of 1896. Besides general articles, it gives notices of the publications of benevolent institutions, social studies of the laboring classes, legal events, and official reports pertaining to subjects within the scope described by its title. The principal article in the January number is on True Beneficence and Legal Beneficence.

Il Pensiero Moderno is a new semi-monthly periodical published at Rome which will deal with all that concerns the modern sociological movement, and the fields of science, literature, and art. The name of Prof. G. Sergi stands at the head of its list of collaborators. The first number contains articles on social hygiene and education. A regular feature will be the fortnightly notes on the more important intellectual and social events within its scope.

We find matter of great interest and value in the *Ethnologisches Notizblatt* of the Direction of the Royal Museum für Völkerkunde in Berlin. The articles are mostly by the director, Dr. A. Bastian, and his assistants, Profs. A. Grünnedel and W. Grube,

and Drs. F. Von Luscher, W. Seler, F. W. K. Müller, and Wenle. In Heft 2 for 1895 we find papers on two old canoe-carvings from New Zealand, various anthropological objects from India, a Japanese picture of the world-mountain, Meru, a number of recent Siamese books and manuscripts, a collection of Chinese idols from Amoy, the latest crossing of Africa, the twenty-fifth annual meeting of the German Anthropological Society, the Siamese art work *Trai-Phum*, or Three Worlds, color studies, the report of our Ethnological Bureau, and a large number of notices of books, societies, etc., relating to anthropology.

A very elaborate examination of the development of Kant's philosophical system is presented in the *Kant-Studien* of Dr. *Erich Addickes* (Kiel and Leipsic: Lipsius and Fischer). In the first part of the essay, which is devoted to this subject specially, the course of the German theory of knowledge from Leibnitz to Kant is reviewed, with analyses of the systems of Leibnitz, Wolff and his followers, and Crusius, after which follow sections on Kant's original point of view, his so-called empiristic period, his conversion in the year 1769, and the inaugural dissertation and Kant's further development. The second part is on the period of the composition of the *Kritik* of Pure Reason.

A volume of *Chemical Experiments*, containing something over two hundred experiments, has been prepared by *Ira Remsen* and *Wyatt W. Randall* to accompany Prof. Remsen's Introduction to the Study of Chemistry (Holt, 50 cents). This laboratory manual includes the experiments in the last edition of the Introduction, minor changes having been made in many of them, and essential changes in a few. There have been also some additions.

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Fragments of Science.

Commerce and Drought.—The serious loss which a prolonged drought may cause, not simply to agriculture, but in an even more marked degree to commerce, is drawn attention to by Prof. L. M. Haupt, in a recent number of the Journal of the Franklin Institute. He says: "One of the most impressive lessons to be derived from the absence of sufficient water for commerce is to be found in the experience of the communities on the upper Ohio River during the past season of exceptional drought. The harbor of Pittsburg, which is made by the movable dam at Davis Island, and the fixed dams of the Monongahela slackwater system, forms a convenient basin in which to make up the tows of coal boats and barges which supply the Mississippi and its tributaries. It is the custom to assemble these tows above the dam and await the pleasure of Pluvius to provide a flood with sufficient depth of water to carry them out. During the past season there has been no coal shipped by river between the 18th of April and the 28th of November (over seven months), and the accumulation of the product had gone on until the tonnage tied up exceeded that of any harbor in the world. For miles on both banks of the river the steamers and their fleets lined the shores, and the danger of their being frozen in all winter was imminent, when a heavy rain released two hundred thousand tons; but a part of these met a watery grave on the shoals of Dead Man's Ripple, a short distance below Pittsburg. The extent of this congestion can not be appreciated by one who has not seen it, and it is far-reaching in its effects, as it directly concerns the industries of millions of people. The actual value of the plant tied up in the harbor of Pittsburg alone, as stated by Hon. John F. Dravo, Secretary of the Coal Exchange, on November 7, 1895, was $6,500,000. At the present time it is costing about two thousand dollars per day to keep this tonnage afloat, besides interest on the investment. This 'tie-up' of Nature has seriously crippled the entire valley, as the railroads can not do more than maintain a partial supply, and the price of fuel has risen in some of the larger cities one dollar a ton." The author cites the above incidents as showing

that a more liberal policy in spending public money for river and harbor improvements would, in the long run, be the most economical.

The Bamboo as a Food.—Young bamboo shoots are eaten by the Chinese and Japanese as we eat asparagus. Dr. Lamounier, who has a collection in his garden at Verneuil, France, tried two or three species at a right age, and found them excellent. The stalks should be taken very young during the first fortnight of spring growth, and should not be more than fifteen centimetres thick. The outer envelopes of spathes are taken off, and the soft substance is left, crisp and brittle, and yielding easily to the pressure of the finger. Dr. Lamounier says they have the general taste and flavor of Brussels sprouts, and that they are wholesome, easily digestible, and economical. But all depends on the time of cutting and the preparation. Some canned bamboo, exhibited by the Japanese at Paris in 1889, was found hard and flavorless. We have these differences, too, in asparagus and all vegetables, while we judge the quality of the same from their best, not from their worst.

Tuberculosis and Meat Inspection.—In a paper presented to the New York Academy of Medicine during last November, Prof. Leonard Pearson, of the University of Pennsylvania, gave a *résumé* of the recent work of foreign veterinarians on bovine tuberculosis. We take the following points from a reprint of the address in the Dietetic and Hygenic Gazette. "This subject," he says, "has been a live one in Europe for many years, and has received much attention ever since it was shown by Villimen, in 1868, that the disease could be transmitted from one animal to another, and more especially since the discovery of the tubercle bacillus by Koch in 1882 and the consequent establishment of the fact that the tuberculosis of men and the lower animals is the same disease and caused by the same germ. Most of the European countries now have a system of meat inspection, which is carried out most carefully in the great centers of population, and usually assures the consumer against harmful flesh. The question as to what shall be done with tuberculous carcasses has excited much discussion. There is practically unanimity regarding the immediate and entire destruction of the carcasses of animals that show generalized tuberculosis, or tuberculosis with marked emaciation, but the cases of localized tuberculosis are much more common, amounting in some places to fifteen or eighteen per cent of all cattle slaughtered. The careful experiments, however, of Chauveau, Nocard, Bollinger, Bang, and McFadyan have shown that the flesh of animals with local tuberculosis is not infectious. It has been shown, however, that if there are any tuberculous spots the butcher is likely to get infected material from this spot on his knife and spread it more or less generally over the carcass. At the International Veterinary Congress held last September in Berne, it was decided by resolution that the flesh of tuberculous animals should be condemned when the carcass is emaciated, when it has a general bad appearance, when tubercles are found in the muscular portions, and when alterations are found in several organs. It was also recommended, in relation to the flesh of slightly tuberculous animals, that it be permitted to go on the market, but that it be sold in special shops or stalls, or sterilized and sold as cooked meat. In Germany the practice is to condemn the worst cases, sterilize those that are less extensive, and to pass as sound the slightly developed cases, after destroying the affected parts. A very important point in connection with this subject is in reference to the payment of indemnity to the owner of the condemned animal or carcass. It is felt that, as the animal is condemned for the good of the public, they should bear part of the loss. Already in France it is the custom to compensate the owners of infected animals which are destroyed. The consideration of the milk from tuberculous cows is also of great importance. Numerous investigations have demonstrated that the milk of cows with tuberculosis of the udder will cause tuberculosis in a very large percentage of the animals fed upon it. Ostertag recommends that the milk from cows with tuberculosis of the udder should be excluded from consumption, and that from cows which react to tuberculin, but show no evidence of tuberculosis of the udder, should be sterilized before sale. In a recent report from the

Royal Commission on Tuberculosis in Animals the statement is made that 'the withdrawal from dairies of every cow that has any disease whatever of the udder would form some approach to security against the serious danger incurred by man from the use of tuberculous milk, but it would not be an adequate security.' The presence in a dairy of a tuberculous cow, the report says, is a decided source of danger to the public, especially having regard to what has been learned respecting the rapid development of tuberculosis of the udder. Regarding the value of tuberculin injections as a diagnostic agent, the following resolutions were adopted at the International Veterinary Congress held last September, and hence represent the opinions of the foremost veterinarians of Europe: 'No. 1. Tuberculin is a very valuable diagnostic agent and can yield the greatest assistance in combating tuberculosis. There is no reason for objecting to its general application on the ground that it may aggravate pre-existing tuberculous lesions. No. 2. The congress expresses the desire that governments shall order the employment of tuberculin in herds in which the existence of tuberculosis has been established.' The official veterinarians of Germany are advised to use tuberculin, and are supplied with it at a low cost from the government laboratories."

Tibetan Women.—As described by Mr. W. W. Rockhill, the Tibetan women are usually stouter than the men, with fuller faces, and do not entirely lose their good looks before they are thirty or thirty-five years old. They are as strong as or perhaps even stronger than the men, because, being obliged to do hard work from childhood, their muscles are more fully developed than those of the men, who do not carry water on their backs, work at the loom, or tend the cattle. Their hair is long and coarse, but not very thick; it remains black, or only mixed with a little white, to extreme old age; and both men and women with white hair are rarely seen. The skin of the Tibetan is coarse and greasy, light brown in color, frequently nearly white, except when exposed to the weather, when it becomes a dark brown, nearly the color of our American Indians. Rosy cheeks are common among the younger women. The Tibetans' voices are powerful, those of the men deep, those of the women full and not very shrill. Their hearing is good, and they can converse freely from one side of a valley to the other, a distance of half a mile, without ever having to repeat phrases or perceptibly raise the voice. They can endure exposure without any apparent inconvenience, the women doing their work with the right side of the body completely exposed, and small children going naked, or with only a pair of boots on, except in the coldest weather. They can also endure hunger, and are at all times small eaters.

A New Glass Construction.—We take the following from a report presented by Dr. Schott to the French Society for the Encouragement of National Industry: For siliceous glasses the expansion increases with the proportion of alkali. Boric acid produces a striking decrease of expansion. In superposing upon each other two glasses of different compositions, it is requisite that there should exist a certain relation between the relative thickness of the two layers of glass and their coefficients of expansion. Thus at Jena they solder normal thermometer glass, the coefficient of cubic expansion of which between 0° and 100° = 0·0000244, to an aluminous sodium borosilicate, the expansion of which = 0·0000177. The former kind of glass must be placed externally and the second internally in order to form a hollow vessel or tube. We may also join together three or more layers of two or more glasses. Of two layers of glass with different expansions after cooling, that with the greatest expansion will be in a state of tension and the other in a state of compression. External layers in a state of compression increase in a striking manner the resistance of glass to mechanical actions and to rapid changes of temperature. Flasks thus manufactured may be strongly heated (to a temperature of 184°), and may then be sprinkled with cold water without injury. Such glasses are not liable to the sudden rupture which is apt to occur in glass tempered by the process of De la Bastie.

An African Village Scene.—"I doubt," says Dr. D. Kerr-Cross, "if finer villages or better built houses exist anywhere in un-

civilized Africa than are found among the 'Wa-nyakyusa' people" of the district north of Lake Nyassa. Round houses are occupied by the married people, but they also build square houses and long cattle-folds. The walls are of bamboo set into the ground at an angle of about 100°. Small bricks about the size of an ostrich egg are fitted neatly, while plastic, into the framework. The whole is a huge basket of bamboo reeds and mud. The reeds on the roof are tied in wavy lines in the form of a dome, the thatch is laid with great skill, and the house is scrupulously clean. Large villages are uncommon, but on the plains one village is connected with another by banana groves which often extend for miles. Trees are planted for utility and for ornamentation, and are regarded with pride. There are no stockaded villages, but a kind of poisonous cactus is grown as a defense. All manual work in cultivation is done with giant hoes. Their fields look as if they had been deeply plowed, and every furrow is perfectly straight. They are a tall, muscular race, of few wants, desiring nothing of strangers. They appreciate cloth, but have little idea of its value. They are in what one might call the "brass-wire age." That is their medium of exchange, and anything can be bought for it. Iron is found in the King's Mountains, and is extensively wrought. They make iron, copper, and brass belts as thick as one's little finger, and wear them on the waist. Six or more of such belts may be worn on the person of one individual. Their word for riches means iron. The Nkonde spears are famed. Though not so large as those of the Masai, their spears and bill-hooks are cruel-looking weapons, with long barbs. The shafts are made of a dark, hard wood, and are frequently dyed black. They are ornamented, and often beautifully inlaid with a delicate tracery of brass, copper, or iron. They have fifteen varieties of spears, bearing different names.

The Storing of Acetylene.—In a recent letter to the Engineering News, Frederick H. Lewis gives the result of some instructive calculations. It has been claimed, it seems, by several concerns that acetylene gas may be liquefied and stored in metal "bottles," and in this form advantageously handled and transported. "The writer," says Mr. Lewis, "had occasion some time since to ascertain whether a small cylinder of about one half cubic foot capacity could possibly contain the amount of gas that the company's orator in Philadelphia had declared it to hold. A little calculation showed that if the gas was present, as stated, its density must be nearly equal to that of cast iron." Mr. Lewis calculates that a cylinder containing sufficient gas to supply a private house for a month would have to be about eight feet and a half long, and would weigh three hundred pounds. "But," he says, "even this statement of the case is entirely too favorable. The fact which the acetylene-gas people must face is this, that it is entirely unsafe to liquefy gas whose critical point is only 98° F., and subject such cylinders to the incidents of transportation and of ordinary use in dwelling houses. It has been found necessary to adopt this view in the case of nitrous oxide for dentists' use, and it will be necessary with acetylene."

Gout and Genius.—From an interesting little essay in the Lancet, by Mr. J. F. Thiselton Dyer, on the folklore of gout, we take the following: Many years ago one Misausus wrote a curious little book in honor of the gout, with the object of proving that it was a blessing for which mankind could not be too thankful, arguing that if Paracelsus could make men proof against death his secret consisted in inoculating them with gout. But when it was suggested that gouty people do die, he replied that men know not when they are well off, but must needs be curing the gout, and therefore deal with death's factor, the physician. It was, however, a popular notion that gout lengthened life, and statistics at the present day show that it is not answerable for more than one death in every seventeen hundred and eighty. For a long time gout had the reputation of being pre-eminently the rich man's disease, and Sydenham, who, it may be remembered, was the first man minutely to study the disease, remarked that, unlike any other complaint, "it kills more rich than poor; more wise than simple. Great kings, emperors, generals, admirals, and philosophers have died of gout." In one of Pitt's last letters to the Marquess Wellesley, he alludes to his slow recovery

from severe attacks of gout, and both the Earl of Chatham and Fox were afflicted by it. Horace Walpole was another victim, and, after comically describing himself as wrapped in flannels, like the picture of a Morocco ambassador, he says: "If either my father or mother had had it, I should not dislike it so much. I am herald enough to approve it if descended genealogically, but it is an absolute upstart in me, and, what is more provoking, I had trusted to my great abstinence for keeping me from it; but thus it is." Sydney Smith, when writing to the Countess of Carlisle in his seventy-first year, speaks of his gout, and humorously says: "What a very singular disease it is! It seems as if the stomach fell down into the feet. The smallest deviation from right diet is immediately punished by limping and lameness, and the innocent ankle and blameless instep are tortured for the vices of the nobler organs." The fact that gout occurs among the poor and temperate Farõe islanders, and that it may be generated by a low diet and abstinence carried to extremes, would seem to indicate that it is not always caused by overfeeding. Among some of the literary men and poets who have suffered from gout may be mentioned Fielding, Newton, Linnæus, Milton, Congreve, and Dryden, and of warriors included among its victims Lord Howe, Marshal Saxe, Wallenstein, and Condé. Dr. Cullen was strongly of opinion that all gout must be considered hereditary. Modern science has somewhat qualified this assertion, maintaining that three out of every five cases may be regarded as inherited. It is worthy of note that where there is a predisposition for gout a fit may be induced by the most opposite causes; and whereas Kingsley's "northeast wind" will excite it in some instances, a mathematical problem has been known to produce it in another. It seems incredible that any one should desire gout, and yet it is said that Archbishop Sheldon not only wished for it, but actually offered as much as five thousand dollars to any person who would keep him to it; for he looked upon gout as "the only remedy for the distress in his head." Gout is not confined to any one class, and has afflicted some of the ablest men in all ages, although, strange to say, it is five times more frequent in men than in women.

The Unapproachable Antarctic Continent.—Whether it will ever be possible to make a satisfactory exploration of the antarctic continent is a matter of doubt, on which very little if any light is shed by the reports of Mr. Borchgrevink, the latest navigator who has tried to penetrate the region. The defenses of the shores against approach are considerably more formidable than those of the arctic seas, and consist of the "pack," a moving mass of icebergs of enormous size, and floating ice; within this, a rim of compact ice, fringing the greater part of the shore, and extending out often several hundred miles from the land; and the ice barrier of the land itself. Captain Cook did not believe that any man would venture farther toward the pole than he had gone; but in 1823 a Captain Weddell found an unusually extended break in the ice fringe, and reached 74° 15′ S., but not the mainland. Yet he found the antarctic islands almost inaccessible, constantly covered with snow, except some perpendicular rocks, and nearly destitute of vegetation. Sir James Ross sailed in sight of the antarctic mountains, a hundred miles away, but was not able to make a landing. Wilkes saw land at several points, but could not pierce the ice barrier. Even if a landing were made, the country does not seem to afford even the poor facilities for exploration which the arctic regions furnish; it has few known animals and no inhabitants, of which arctic travelers are often able to make considerable use.

Metallic Iron in Water Purification.—Mr. F. A. Anderson recently delivered an interesting address before the Society of Arts on the purification of water by means of metallic iron. While this method is not a new one, and has been in use in various English towns for some years, Mr. Anderson's paper is worthy of attention as giving a very clear description of the apparatus and methods of the process. He says: "The idea of purifying water by agitating it with metallic iron is due to Sir Frederick Abel. The revolving purifier is a cylindrical vessel, supported horizontally upon hollow trunnions, through one of which the water to be purified enters; after traversing the cylinder it leaves by the other trunnion. The cylinder is caused to rotate about its axis by means

of a gearing. A number of curved shelves running longitudinally are fixed inside of the cylinder. The iron may be in any convenient form, but the most commonly employed in practice is the burrs or punchings from plates. The charge varies, of course, with the size of the cylinder, a purifier capable of treating a million gallons of water in twenty-four hours requiring about two tons. When the machine is set in motion, the curved shelves scoop up the charge of iron and shower it down through the water, thus causing a constant falling of iron across the current of the water. The effect upon the water of the agitation with iron is simply to cause a small quantity of iron, from one tenth to one fifth of a grain per gallon, to be dissolved. The water emerges from the purifier and passes to settling tanks, where the ferrous hydrate, which has been formed, is oxidized into ferric hydrate, and settles to the bottom of the tank. From the settling arrangement the water passes on to the filters, which are sand beds of ordinary construction; through these filters the water passes at the rate of from eighty to one hundred gallons per square foot per twenty-four hours, and emerges pure and free from any trace of iron. It was formerly considered that the iron had a more or less pronounced chemical action upon the dissolved organic impurities of the water; the oxide formed was considered to act as a carrier of oxygen, by means of which the organic matters were actually burned up and destroyed. It is tolerably certain now, however, that the real action is one of coagulation; the formation of a precipitate in the water tending to throw out of solution the dissolved organic substances, which form with the ferric hydrate insoluble compounds, so to speak, which are removed from the water by settlement and filtration. This view of the action of the iron upon the organic impurities of a water applies equally well to its action upon microbes. The germs are entangled in the gelatinous precipitate, and either subside with it to the bottom of the settling tank, or remain behind on the surface of the filter. Moreover, the film of oxide which covers the surface of the sand appears to act like a Chamberland-Pasteur filter, retaining the microbes while allowing the water to pass freely. A very important feature of the iron process consists in the rapidity with which perfect results are secured. A sand filter of ordinary construction will remove a very large proportion of the microbes in a water when its surface has become sufficiently blocked by the layer of matter, living and dead, separated from the water being filtered. To obtain this result, however, it is necessary to work the filter for days, delivering all the while imperfectly filtered water, until this layer has time to form. With the iron process, however, no such thing occurs. The practice is, when a filter is restarted after cleaning, to refill it from below with purified water from another filter until the surface of the sand is submerged; and then to admit from above water direct from the outlet of the purifiers, containing in suspension the whole of the iron oxide supplied to it. This turbid water as it settles immediately forms the desired film. Then the filter is set to work, and yields, from the first, water containing the minimum number of germs. The film thus formed is quite clean, and is never slimy or offensive.

Recent Experiments in Flying.—In an interesting article in Nature describing and picturing the flying appliances of Herr Otto Lilienthal, who has been experimenting for some time past near Berlin, it is said that his experiments "have from the very beginning been rewarded with a distinct success; and it seems that, given time, he may present us if not with a method of flying, then with an approximation to it, which perhaps at some later date may be more fully developed." He has already succeeded in making fairly long flights with perfect safety. His present apparatus consists of two parallel planes one above the other, the upper being about three fourths of a wing breadth above the lower. Each plane has an area of nine square metres. The planes are slightly concave on the lower side, and each one is divided into two wings by a fore-and-aft hinge. There are two rudders at right angles to each other fastened to the rear end of the lower plane. With this new apparatus Herr Lilienthal has already found that a step in the right direction has been made. The energetic movement of the center of gravity, and the consequent more safe management of the apparatus, had led him to practice in winds

blowing at times over ten metres per second. "These experiments," he says, "have given the most interesting results that I have arrived at since I began." With a wind velocity of six or seven metres per second, the sailing surface of eighteen square metres carried him against the wind in a nearly horizontal direction from the top of the hill without even having to run at the start, as is generally necessary. In a stronger wind he allows himself to be simply lifted by the wind from the hilltop and sail slowly against it. As experiments have shown, the sailing path is directed strongly upward by increasing wind force, and this fact causes him sometimes to be higher in the air than he was at his original starting point. In this position his apparatus has occasionally come to a standstill; and this leads him to make the following interesting statement: "At these times I feel very certain that if I leaned a little to one side, and so described a circle, and further partook of the motion of the lifting air around me, I should sustain my position. The wind itself tends to direct this motion. I have made up my mind by means of either a stronger wind or by flapping the wings to get higher up and farther away from the hill, so that, sailing round in circles, I can follow the strong uplifting currents and have sufficient air space under and about me to complete with safety a circle, and lastly to come up against the wind again to land."

MINOR PARAGRAPHS.

In a recent report to the French Academy of Medicine, M. Henri Monod says that from January, 1895, since the knowledge of antidiphtheritic serum and its uses has been extensively diffused throughout France, the statistics have shown a marked diminution in the mortality from the disease. In the population of one hundred and eight cities in France, each having more than twenty thousand inhabitants (the only places from which the reports are sent to the central administration), during the first six months of the seven years preceding 1895—that is, from 1888 to 1894—the average number of deaths was twenty-six hundred and twenty-seven. During the first six months of 1895 the diminution was 65·6 per cent. This diminution is not simply continuous, but is steadily increasing, as is proved by statistics from month to month. In a little pamphlet on this subject by Dr. Welch, of the Smithsonian Institution, he says that "the study so far of the results of the treatment of over seven thousand cases of diphtheria by antitoxine demonstrates beyond all reasonable doubt that antidiphtheritic serum is a specific curative agent for diphtheria, surpassing in its efficacy all other known methods of treatment for this disease," while "the essential harmlessness of the serum has been demonstrated by over a hundred thousand injections."

An accident of considerable scientific interest recently resulted in the photographing of a meteor. On November 23d last, at about ten minutes past twelve at night, Mr. C. P. Butler, of Knightsbridge, with the intention of focusing and testing the field of a new lens, placed a quarter-plate camera on the window sill, pointed it roughly at the region near the boundaries of Perseus, Andromeda, and Aries, and exposed it for about ten minutes. Upon developing the plate, the track of a meteor was the first impression to be perceived. Confirmation of the occurrence of the meteor is given by its having been observed from the South Kensington Observatory, both the time of the fall and the estimated region of its path being identical with the above observations.

M. Berthelot, says Industries and Iron, with the view of avoiding the inaccuracy arising from the unknown or irregular expansion of the containing vessel of the gas thermometer, has recently been experimenting with a new method of measuring temperatures. He employs the varying refractive power of gases at different densities. A given refraction always corresponds to a given density, though the pressure and temperature may be different. The principle is applied by the method of interference. A luminous beam is split up into two parts, which traverse two tubes filled with the same gas, and the initial appearance of the interference fringes is noted. One of the tubes is then raised to the temperature which it is

desired to measure, the pressure remaining constant and being that of the atmosphere. As the density of the gas diminishes, the interference fringes become displaced. By reducing the pressure of the gas in the second or cold tube, the fringes are brought back to their initial position; and this means that the density is then the same in both tubes. Now, the refraction of a gas is always exactly proportional to its density: the density of the gas in the cold tube is known from its pressure. Hence the density of the hot tube is also known, and from this its temperature is deduced. The method is thought to be well adapted for the measurement of high temperatures, such as those of furnaces.

NOTES.

ABUNDANT testimony is cited by Mr. Walter Hough to the fact that the use of body armor was at one time general if not universal among the North American Indian tribes. The form was usually that of a sleeveless jacket, coat, or wide band, going around the trunk, suspended from the shoulders. At the period of its disuse, six types of armor were found on this continent and in contiguous regions—viz., rows of overlapping plates, perforated and lashed; wooden slats twined together; wooden rods twined together; bands of skin arranged in telescope fashion; coats of hardened hide; and cotton-padded armor.

PROF. MARSHALL WARD has found from his experimental work of the past few years that the appearance of colonies of the same bacterium, when grown under different conditions, are often very unlike. Distinctions of species, therefore, should not be based only upon the appearance of the colony, but should be drawn after study of all the conditions of the medium.

DR. TREUB, director of the botanical gardens of Buitenzorg, Java, gave an account, in the British Association, of the formation of hydrocyanic acid in the pangia tree (*Pangium edule*), and especially of the relation of the acid to the formation of nitrogenous material in plants. He considers that it is, in pangium at least, the first detectable nitrogenous material, and suggested, as an inference, that it is possibly very widely distributed in the vegetable kingdom as a transitory substance which becomes rapidly transformed into more complex substances.

THE agitation of a proposition to rename one of the boulevards of Paris after Pasteur has developed the fact that besides there being already a rue Pasteur, twenty-one streets in Paris are named after chemists. Among the men thus remembered are Chevreul, Gay-Lussac, Lavoisier, Raspail, Davy, and Berzelius. Seven botanists are thus honored, one alchemist—Nicholas Flannel, of the fourteenth century—and twenty-nine doctors and surgeons.

WE gather from an article in Science that the *Conseil Supérieur de l'Instruction Publique* has issued a decree, removing the restrictions upon the admission of American and other foreign students to the French universities, and giving them a status substantially similar to that accorded by the German universities.

THE gold medal of the Royal Astronomical Society has this year been awarded to Dr. S. C. Chandler, of Boston. Dr. Chandler's astronomical labors have been exceedingly numerous; but that which has attracted most attention is an investigation showing the probability that some small fluctuations of latitude, which had been noticed in particular places, were due to a motion of the earth's axis causing the poles to describe circles, thirty feet in radius, round a center, the period of this motion being about fourteen months.

A RECENT improvement in the simple pendulum for purposes of measurement is reported as having been made by G. Guglielmo. The simple pendulum oscillates about its point of suspension in all directions. The compound pendulum rests on a knife edge, or essentially on two points some distance apart, and therefore oscillates always in the same plane. A bob suspended by two threads will do the same. But for some purposes it is highly desirable to have a body oscillating in the same plane and parallel to itself. Sgr. Guglielmo has accomplished this by taking two such bifilar pendulums and joining them by a horizontal rod placed in their plane of vibration. A very useful application of it is an anemometer designed on this plan.

THE average weekly earnings of laboring men in the United Kingdom are computed in the latest Blue Book to be 27*s.* 7*d.*, or £64 ($320) a year. But while this is the average, it is made up by balancing the wages of those who earn more and those who earn less; and it further appears that twenty-four per cent of the laboring men of the country have less than £1, or $5, per week.

LUDWIG RÜTIMEYER, the distinguished naturalist, who died on the 26th of last November, was born at Biglen, in the Canton Bern, in 1825. His father was the parish clergyman, and the son intended to follow in his father's footsteps; but he was from his youth more interested in natural history than in theology. In 1848 he began the study of medicine, and for the rest of his life devoted himself to the study of comparative anatomy.